

# **Brazilian Tables for Poultry and Swine**

**Composition of Feedstuffs and Nutritional  
Requirements**

**2<sup>nd</sup> Edition**

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## 2ª EDITION

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## **INTRODUCTION**

Brazil is one of the world's largest poultry and swine producer, and consequently, of compound feeds as well.

The level of technology used by the Brazilian poultry and swine producers is generally high, especially in the feed industry. However, feed formulation technology was based of information on feedstuff composition and nutritional requirements determined mainly in the United States and in Europe. The tables used for feed calculation, both in companies and research institutions, were published abroad, or published in Brazil, but using data generated elsewhere.

It is indubitable that the use of foreign tables promoted the adoption of high-level technology, resulting in the development observed in the Brazilian industry today, but some data are not fully applied to Brazilian circumstances.

The Federal University of Viçosa (UFV) started a series of experiments and research studies in 1974, which aim was to produce a table of composition of feedstuffs and nutritional requirements of poultry and swine with data generated in Brazil. This resulted in the publication of the first BRAZILIAN TABLE OF COMPOSITION OF FEEDSTUFFS AND NUTRITIONAL REQUIREMENTS in 1983.

From 1983 until 2000, research continued, generating a significant body of scientific information on feedstuff composition and poultry and swine requirements that resulted in the publication of the 1<sup>st</sup> Edition of the Brazilian Tables for Poultry and Swine. Continuing research made the update of this information possible with the publication of the second edition of the tables.

Most of the data presented here were already published in scientific journals, M. Sc. and Ph. D. theses, as well as in the proceedings of scientific meetings and congresses. Most of the papers can be found in the Revista Brasileira de Zootecnia, in the proceedings of the meetings of the Brazilian Society of Animal Science, in the proceedings of APINCO Foundation of Poultry Science and Technology and other publications.

To prepare the Brazilian tables of composition, thousands of analyses of feedstuffs produced in Brazil were made. Several trials with animals were carried out in animal nutrition laboratories to determine particularly energy values, as well as numerous chemical analyses.

The determination of nutritional requirements involved the performance of many biological assays with broilers, layers and pigs in different rearing and production stages, under different environmental and temperature conditions.

The data obtained were tested under rigorous experimental conditions, involving the observation of commercial-size groups of animals. Least cost rations were calculated using feedstuff nutritional values and nutritional requirements determined at UFV and these were compared to diets which calculation was based on international tables. The new information published here will allow the Brazilian animal scientists the formulation of diets adapted to local conditions.

The aim of the authors was to contribute for the improvement of animal production in Brazil. Nevertheless, we are aware that the continuation of research studies, associated to the collaboration of researchers, technicians, and producers will allow the further improvement of this information.

*The authors*

## CONTENTS

### CHAPTER 1.

Composition of Feedstuffs and of Vitamin and Mineral Supplements.....	15
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### CHAPTER 2.

Nutritional Requirements of Poultry.....	71
Nutritional Requirements of Broiler Chickens .....	79
Nutritional Requirements of Replacement Pullets and Layers	93
Nutritional Requirements of Broiler Breeders.....	113

### CHAPTER 3.

Nutritional Requirements of Swine.....	127
Nutritional Requirements of Gowing Swine.....	133
Nutritional Requirements of Swine Breeders.....	151

### CHAPTER 4.

Simplified Tables of Feedstuff Composition and Nutritional Requirements of Poultry and Swine.....	159
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### CHAPTER 5.

Theses.....	165
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## LIST OF TABLES

Table 1	- Chemical Composition and Energy Values of Poultry and Swine Feedstuffs (as fed).....	21
Table 2	- Equations to Estimate the Metabolizable Energy of Feedstuffs for Poultry.....	37
Table 3	- Equations to Estimate Energy Values of Feedstuffs for Swine.....	38
Table 4	- Equation to Estimate Metabolizable Energy Lost (MEL) for Poultry as a Function of Corn Grading / Type.....	39
Table 5	- Total and Digestible Amino Acid Content of Poultry and Swine Feedstuffs (as fed) .....	40
Table 6	- Composition, Digestibility and Energy Values of Synthetic Amino Acids for Poultry (dry matter basis).....	53
Table 7	- Composition, Digestibility and Energy Values of Synthetic Amino Acids for Swine (dry matter basis) .....	54
Table 8	- Mineral Sources for Poultry and Swine (as fed).....	55
Table 9	- Mineral Content of Brazilian Phosphates (as fed)...	56
Table 10	- Mineral Content of Feedstuffs (as fed).....	57
Table 11	- Sources of Trace Minerals Used to Supplement Poultry and Swine Diets.....	59
Table 12	- Vitamin and Mineral Supplementation Levels in Poultry Diets (amount / kg diet).....	60
Table 13	- Mineral Supplement for Poultry Diets.....	61
Table 14	- Vitamin and Mineral Supplementation Levels in Swine Diets (amount / kg diet).....	62
Table 15	- Mineral Supplement for Swine Diets.....	63
Table 16	- Practical (Pr) and Maximum (Max) Inclusion Levels of Feedstuffs in Broiler and Layer Diets (percentage in the diet).....	64

Table 17 -	Practical (Pr) and Maximum (Máx) Inclusion Levels of Feedstuffs in Growing and Breeder Swine Diets (percentage in the diet).....	66
Table 18 -	Variation in Nutrient Content of Primary Feedstuffs - Crude Protein, Calcium and Phosphorus. (as fed).....	68
Table 19 -	Variation in Nutrient Content of Primary Feedstuffs - Lysine, Methionine + Cystine and Threonine (as fed)..	69
Table 20 -	Methodology Used to Obtain the Equation that Calculates the True Digestible Lysine / kg Weight Gain of Broilers (Males and Females).....	81
Table 21 -	Equation Used to Estimate True Digestible Lysine (Dig. Lys.) Requirements of Broilers.....	82
Table 22 -	Digestible Lysine Requirement of of Broiler Males with Standard Performance Using the Equation of Table 21.....	83
Table 23 -	Digestible Lysine Requirement of of Broiler Females with Standard Performance Using the Equation of Table 21.....	84
Table 24 -	Amino Acid / Lysine Ratio Used to Estimate Amino Acid Requirements of Broiler Chickens.....	85
Table 25 -	Equations Used to Estimate the Nutritional Requirements (Y) of Broilers, in % per Mcal ME as a Function of Age (X).....	86
Table 26 -	Nutritional Requirements of Broiler Males with Below Average Performance.....	87
Table 27 -	Nutritional Requirements of Broiler Males with Standard Performance.....	88
Table 28 -	Nutritional Requirements of Broiler Males with High Performance.....	89
Table 29 -	Nutritional Requirements of Broiler Females with Below Average Performance.....	90
Table 30 -	Nutritional Requirements of Broiler Females with Standard Performance.....	91
Table 31 -	Nutritional Requirements of Broiler Females with High Performance.....	92

Table 32 - Amino Acid / Lysine Ratio Used to Estimate Amino Acid Requirements of White-Egg and Brown-Egg Replacement Pullets.....	95
Table 33 - Nutritional Requirements of White-Egg Replacement Pullets (% per 1000 kcal ME diet).....	96
Table 34 - Nutritional Requirements of Brown-Egg Replacement Pullets (% per 1000 kcal ME diet).....	97
Table 35 - Nutritional Requirements of White-Egg Replacement Pullets According to Dietary Energy Level.....	98
Table 36 - Nutritional Requirements of Brown-Egg Replacement Pullets According to Dietary Energy Level.....	99
Table 37 - Equation Used to Estimate True Digestible Lysine (Dig. Lys.) Requirements of White-Egg and Brown-Egg Layers in g/bird/day and in %.....	100
Table 38 - Equation Used to Estimate Metabolizable Energy (ME) Requirements of White-Egg and Brown-Egg Layers in kcal/bird/day.....	101
Table 39 - Digestible Lysine (Dig. Lys.) Requirement of White-Egg Layers According to Productivity.....	102
Table 40 - Digestible Lysine (Dig. Lys.) Requirement of Brown-Egg Layers According to Productivity.....	103
Table 41 - Amino Acid / Lysine Ratio Used to Estimate Amino Acid Requirements of White-Egg and Brown-Egg Layers.....	104
Table 42 - Nutritional Requirements of White-Egg Layers (g/bird/day).....	105
Table 43 - Nutritional Requirements of Brown-Egg Layers (g/bird/day).....	106
Table 44 - Energy Requirement (kcal ME /bird/day) and Feed Intake (g/bird/day) of White-Egg and Brown-Egg Layers.	107
Table 45 - Nutritional Requirements (%) of White-Egg Layers According to Productivity, Metabolizable Energy and Feed Intake	108

Table 46 -	Nutritional Requirements (%) of White-Egg Layers According to Productivity, Metabolizable Energy and Feed Intake, Under Different Temperatures.....	109
Table 47 -	Nutritional Requirements (%) of Brown-Egg Layers According to Productivity, Metabolizable Energy and Feed Intake.....	110
Table 48 -	Nutritional Requirements (%) of Brown-Egg Layers According to Productivity, Metabolizable Energy and Feed Intake, Under Different Temperatures .....	111
Table 49 -	Amino Acid / Lysine Ratio Used to Estimate Amino Acid Requirements of Replacement Broiler Breeder Pullets.....	115
Table 50 -	Nutritional Requirements of Broiler Breeder Pullets (% per 1000 kcal ME diet).....	116
Table 51 -	Nutritional Requirements of Broiler Breeder Pullets According to Dietary Energy Level.....	117
Table 52 -	Equation Used to Estimate True Digestible Lysine Requirement of Broiler Breeder Hens in g/bird/day and in %.....	118
Table 53 -	Equation Used to Estimate Metabolizable Energy (ME) Requirements of Broiler Breeder Hens in kcal/bird/day.....	119
Table 54 -	Digestible Lysine (Dig. Lys.) Requirements of Broiler Breeder Hens According to Productivity.....	120
Table 55 -	Amino Acid / Lysine Ratio Used to Estimate Amino Acid Requirements of Broiler Breeders.....	121
Table 56 -	Nutritional Requirements of Broiler Breeder Hens (g/bird/day).....	122
Table 57 -	Energy Requirements (kcal ME/bird/day) and Feed Intake (g/bird/day) of Broiler Breeder Hens.....	123
Table 58 -	Nutritional Requirements (%) of Broiler Breeder Hens According to Productivity, Metabolizable Energy and Feed Intake.....	124

Table 59 -	Nutritional Requirements (%) of Broiler Breeder Hens According to Productivity, Metabolizable Energy and Feed Intake, Under Different Temperatures.....	125
Table 60 -	Nutritional Requirements of Broiler Cockerels According to Metabolizable Energy and Feed Intake (g/day ou %).....	126
Table 61 -	Methodology Used to Obtain the Equation that Calculates the True Digestible Lysine / kg of Weight Gain of Barrows of High Genetic Potential..	135
Table 62 -	Equation Used to Estimate True Digestible Lysine (Dig. Lys.) Requirement of Barrows of High Genetic Potential.....	136
Table 63 -	Methodology Used to Obtain the Equation that Calculates the True Digestible Lysine / kg of Weight Gain of Gilts of High Genetic Potential.....	137
Table 64 -	Equation Used to Estimate True Digestible Lysine (Dig. Lys.) Requirement of Gilts of High Genetic Potential.....	138
Table 65 -	Digestible Lysine (Dig. Lys.) Requirement of Barrows of High Genetic Potential with Standard Performance Using Equation of Table 62.....	139
Table 66 -	Digestible Lysine (Dig. Lys.) Requirement of Gilts of High Genetic Potential with Standard Performance Using Equation of Table 64.....	140
Table 67 -	Amino Acid / Lysine Ratio Used to Estimate Amino Acid Requirements of Growing Swine.....	141
Table 68 -	Equations to Estimate the Nutritional Requirements of Growing Pigs (15 to 120 kg) in Percentage / Mcal ME as a Function of Live Weight.....	142
Table 69 -	Nutritional Requirements of Piglets of High Genetic Potential in the Pre-Starter Phase with Standard Performance (Barrows and Gilts).....	143
Table 70 -	Nutritional Requirements of Barrows of High Genetic Potential with Below Average Performance.....	144
Table 71 -	Nutritional Requirements of Barrows of High Genetic Potential with Standard Performance.....	145

Table 72 -	Nutritional Requirements of Barrows of High Genetic Potential with High Performance.....	146
Table 73 -	Nutritional Requirements of Gilts of High Genetic Potential with Below Average Performance.....	147
Table 74 -	Nutritional Requirements of Gilts of High Genetic Potential with Standard Performance.....	148
Table 75 -	Nutritional Requirements of Gilts of High Genetic Potential with High Performance.....	149
Table 76 -	Amino Acid / Lysine Ratio Used to Estimate Amino Acid Requirements of Swine Breeders.....	153
Table 77 -	Nutritional Requirements of Gestating Sows (kcal or g/animal/day).....	154
Table 78 -	Nutritional Requirements of Lactating Sows (kcal or g/animal/day).....	155
Table 79 -	Nutritional Requirements of Gestating Sows According to Feed Intake.....	156
Table 80 -	Nutritional Requirements of Lactating Sows According to Feed Intake.....	157
Table 81 -	Composition and Energy Values of the Most Common Feedstuffs Used in Poultry and Swine Diets (as fed).....	161
Table 82 -	Nutritional Requirements of Male and Female Broilers with Standard Performance.....	162
Table 83 -	Nutritional Requirements of Replacement Pullets, Layers and Broiler Breeders.....	163
Table 84 -	Nutritional Requirements of Swine with High Genetic Potential.....	164

## **CHAPTER 1**

### **Composition of Feedstuffs and of Vitamin and Mineral Supplements**





## INTRODUCTION

Chemical analyses of the ingredients deserved special care. Most of these analyses were carried out at the Animal Nutrition Laboratory of the Department of Animal Sciences of the Universidade Federal de Viçosa (UFV).

- \* The following methodologies were adopted for the determination of the chemical composition: Dry matter content (DM), sample dried in oven at 105 °C for 4 to 6 hours; crude protein (CP), classic method of Kjeldahl; ether extract (EE), hot method, using “Goldfisch” extract and petrol ether as solvent; starch, enzymatic method; crude Fiber (CF) method of Weende; neutral detergent Fiber (NDF) and acid detergent Fiber (ADF), method of Van Soest; gross energy (GE), bomb calorimeter “Parr”. Ash, sample incinerated at 600 °C for 4 hours; the minerals were determined by atomic absorption spectrophotometer, except for sodium and potassium (flame spectrophotometer) and phosphorus by colorimeter. In a limited number of feedstuffs, minerals were also analyzed by the plasma induction spectrophotometer of the Soil Department of UFV.
- \* Potassium, sodium and chloride content in the feedstuffs were included in Table 1 to allow the calculation of the electrolytic (cation - anion) balance of poultry and swine rations.
- \* The variation in the phytic phosphorus content of feedstuffs and the availability of this P and also of non-phytic P were not taken into consideration. P availability was calculated from the total P content and was considered as 100% available in animal products and 33% in vegetable / plant products, except for rice bran, in which the P availability was considered to be 20%. Phosphorus content and availability in different Brazilian phosphates are described in Table 8. P bioavailability in these

phosphates was determined using a reference source - dicalcium phosphate - which coefficient of availability was considered as 100%. For this reason, some phosphates show available phosphorus contents higher than 100%. The true digestible phosphorus values of some feedstuffs determined with grower and finisher pigs are also presented. Studies are being currently conducted at UFV on phosphorus digestibility for poultry and swine aiming at collecting data and to include digestible phosphorus requirements for these animals in the next edition of the Brazilian tables.

- \* Foreign literature reports that some phosphates may present high levels of heavy metals. Table 9 shows data of Brazilian phosphate composition, particularly as to the content of important minerals, such as lead, cadmium, and vanadium.
- \* Metabolizable energy (ME) in feedstuffs for poultry was determined using the method of total excreta collection. Only in some cases chromium oxide was used as fecal marker. ME values presented in Table 1 are values corrected for nitrogen retention and were determined with chickens of different ages (chicks, cockerels and layers).
- \* Energy values (digestible energy and metabolizable energy) and protein digestibility in feedstuffs for swine were determined using metabolic cages, using total collection of feces and ferric oxide as fecal marker. Swine of different ages and weights were used. Table 1 shows feedstuff net energy values for swine. These values were obtained by using the equation developed in France by Dr. J. Noblet and it is described in Table 3.
- \* Several digestibility trials were conducted with grower and finisher pigs in order to determine digestibility coefficients of fat, CF, NDF and ADF in feedstuffs. Organic matter coefficient of digestibility for swine was calculated by the ratio between

digestible energy and gross energy of the feedstuffs. Literature data were used to estimate coefficients of digestibility of fat and nitrogen free extract (NFE) of feedstuff for poultry (Table 1).

- \* To facilitate the correction of feedstuff energy values according to the variation in composition, equations to estimate metabolizable energy of feedstuffs for poultry were developed (Table 2) as well as to estimate digestible energy and metabolizable energy for swine (Table 3). Composition data and coefficients of digestibility of the main nutrients were used. In order to have data in the equations similar to the energy values determined at UFV, coefficients of digestibility of fat (poultry and swine), nitrogen free extract (poultry) and organic matter (swine) were slightly adjusted. Feedstuffs which composition is different from that presented in Table 1 will have different energy values, these new values can then be used to correct and to adjust feedstuff composition matrix.
- \* Table 5 shows total and true digestible amino acid content of feedstuffs for poultry and swine. The methods used to determine amino acid content in feedstuffs and their true digestibility for poultry and swine are expensive and laborious. However, thanks to the companies Ajinomoto and Degussa, it was possible to obtain a large number of analyses, that otherwise could not be carried out in the UFV.
- \* To determine true digestible amino acid content of feedstuffs for poultry, the precision-feeding method of Sibbald with cecectomized cockerels was utilized. Broiler chicks were used for only a small number of feedstuffs in order to determine the true ileal digestibility of amino acids. In swine, animals were submitted to ileal-rectal anastomosis or fitted with ileal reentrant cannula. The coefficient of protein digestibility for poultry was estimated by the ratio between true digestible amino acids and total amino acids in the feedstuffs.

- \* In Brazil, most wheat mills produce only one by-product during wheat processing, that is a mixture of bran and middlings, which is the product mentioned in Tables 1 and 5 as wheat bran-midds.
- \* In this chapter, vitamin and trace mineral supplementation levels for poultry and swine rations are also presented. Diets with these supplementation levels (Tables 12 and 14) should not cause any deficiency problems. Tables 13 and 15 show trace minerals supplementation per kg of poultry and swine rations with the energy levels commonly used in Brazil.
- \* In order to make the use of alternative feedstuffs easier, Tables 16 and 17 present their recommended levels of inclusion in poultry and swine diets, respectively. These are practical levels, that is, the percentage normally included in the diet and maximum inclusion levels that will not affect negatively animal performance.
- \* Tables 18 and 19 show the standard deviations in nutrient composition of the most important feedstuffs used in poultry and swine rations in Brazil. These deviations and coefficients of variation can be used as correction factors in order to avoid possible nutritional deficiencies due to variation in feedstuff composition. However, it is recommended to perform chemical analyses of feedstuffs whenever possible.
- \* A simplified table showing the nutrient content of the most common feedstuffs used in poultry and swine feed formulation is at the end of this publication (Table 81) allowing a quick reference guide.

Table 1 - Chemical Composition and Energy Values of Poultry and Swine Feedstuffs (as fed)

Nutrient		Bakery - Cracker Residue	Blood Plasma	Blood Meal	Canola Meal	Carob Meal
Dry Matter	%	91.43	90.55	92.79	88.54	90.67
Crude Protein (CP)	%	8.56	72.20	82.80	37.58	8.79
Coef. Dig. CP Poultry	%	80.00	95.00	79.00	73.00	-
Digestible CP Poultry	%	6.85	68.59	65.41	27.43	-
Coef. Dig. CP Swine	%	83.00	96.00	71.60	69.20	43.57
Digestible CP Swine	%	7.10	69.31	59.28	26.01	3.83
Fat	%	11.29	1.35	0.48	1.21	0.52
Coef. Dig. Fat Poultry <sup>1</sup>	%	96.00	95.00	80.00	75.00	-
Digestible Fat Poultry	%	10.84	1.29	0.38	0.91	-
Coef. Dig. Fat Swine <sup>1</sup>	%	98.00	95.00	70.00	75.00	-
Digestible Fat Swine	%	11.07	1.29	0.34	0.91	-
Linoleic acid	%	1.98	-	-	-	-
Linolenic acid	%	-	-	-	-	-
Starch	%	46.50	-	-	-	-
Crude Fiber (CF)	%	1.80	-	-	10.45	-
Coef. Dig. CF Swine	%	-	-	-	-	-
NDF	%	6.50	-	-	24.48	17.68
Coef. Dig. NDF Swine	%	-	-	-	-	-
ADF	%	2.20	-	-	2.05	-
Coef. Dig. ADF Swine	%	-	-	-	-	-
Nitrogen Free Extract (NFE)	%	67.94	5.07	6.07	33.48	77.91
Coef. Dig. NFE Poultry <sup>1</sup>	%	96.00	-	-	30.80	-
Digestible NFE Poultry	%	65.22	-	-	10.31	-
Organic Matter (OM)	%	89.59	78.63	89.35	82.71	87.22
Coef. Dig. OM Swine <sup>1</sup>	%	-	85.56	65.86	78.50	59.43
Digestible OM Swine	%	-	67.27	58.84	64.93	51.84
Ash	%	1.84	11.93	3.44	5.83	3.45
Calcium	%	0.06	0.20	0.23	0.56	0.27
Total Phosphorus (P)	%	0.14	0.44	0.22	0.81	0.14
Available P <sup>1</sup>	%	0.05	0.44	0.22	0.27	0.05
True Dig. Coef. P Swine	%	-	-	-	-	-
True Digestible P Swine	%	-	-	-	-	-
Potassium	%	0.17	0.56	0.26	0.55	0.91
Sodium	%	0.19	3.12	0.48	0.11	-
Chloride	%	0.30	-	0.36	-	-
Gross Energy	Kcal/kg	4437	4732	5134	4241	4501
Met. Energy Poultry	Kcal/kg	4010	3087	2857	1692	1520
True Met. Energy Poultry	Kcal/kg	4217	3304	3067	1900	1807
Digestible Energy Swine	Kcal/kg	-	4049	3381	3160	2675
Met. Energy Swine	Kcal/kg	-	3714	2986	2950	2432
Net Energy Swine <sup>1</sup>	Kcal/kg	-	2245	1631	1816	1723

<sup>1</sup> Calculated or estimated values.

Table 1 - Chemical Composition and Energy Values of Poultry and Swine Feedstuffs (as fed)

Nutrient		Casein	Cassava with Hulls Dried	Castor Oil Plant Meal	Citrus Pulp	Coconut Meal
Dry Matter	%	91.35	87.67	89.40	88.44	90.90
Crude Protein (CP)	%	84.21	2.47	39.20	6.37	21.85
Coef. Dig. CP Poultry	%	97.94	46.00	-	27.70	71.20
Digestible CP Poultry	%	82.48	1.14	-	1.76	15.56
Coef. Dig. CP Swine	%	98.00	35.00	-	55.00	67.30
Digestible CP Swine	%	82.53	0.87	-	3.50	14.71
Fat	%	0.80	0.59	1.55	2.02	3.15
Coef. Dig. Fat Poultry <sup>1</sup>	%	-	20.00	-	-	-
Digestible Fat Poultry	%	-	0.12	-	-	-
Coef. Dig. Fat Swine <sup>1</sup>	%	-	42.50	-	55.00	65.00
Digestible Fat Swine	%	-	0.25	-	1.11	2.05
Linoleic acid	%	-	0.08	-	0.45	0.04
Linolenic acid	%	-	-	-	0.08	-
Starch	%	-	67.85	-	-	-
Crude Fiber (CF)	%	-	5.42	18.50	12.70	13.90
Coef. Dig. CF Swine	%	-	64.60	-	-	-
NDF	%	-	11.75	-	-	51.35
Coef. Dig. NDF Swine	%	-	59.00	-	-	-
ADF	%	-	4.27	-	-	27.10
Coef. Dig. ADF Swine	%	-	-	-	-	-
Nitrogen Free Extract (NFE)	%	3.74	75.59	23.35	61.10	45.64
Coef. Dig. NFE Poultry <sup>1</sup>	%	-	93.00	-	-	-
Digestible NFE Poultry	%	-	70.30	-	-	-
Organic Matter (OM)	%	88.75	84.07	82.60	82.19	84.54
Coef. Dig. OM Swine <sup>1</sup>	%	79.83	86.80	-	83.50	77.10
Digestible OM Swine	%	70.85	72.97	-	68.62	65.18
Ash	%	2.60	3.60	6.80	6.26	6.36
Calcium	%	0.40	0.20	0.62	1.57	0.18
Total Phosphorus (P)	%	0.70	0.09	0.62	0.20	0.61
Available P <sup>1</sup>	%	0.70	0.03	0.21	0.06	0.20
True Dig. Coef. P Swine	%	-	-	-	-	-
True Digestible P Swine	%	-	-	-	-	-
Potassium	%	0.01	0.52	0.60	0.75	1.61
Sodium	%	0.01	0.03	0.01	0.07	0.05
Chloride	%	0.04	0.05	-	0.05	0.80
Gross Energy	Kcal/kg	5210	3621	-	3701	3979
Met. Energy Poultry	Kcal/kg	3900	2973	1484	1100	1921
True Met. Energy Poultry	Kcal/kg	-	3192	-	-	2323
Digestible Energy Swine	Kcal/kg	4159	3048	2230	2956	3030
Met. Energy Swine	Kcal/kg	3529	3020	2084	2863	2885
Net Energy Swine <sup>1</sup>	Kcal/kg	2022	2394	-	1951	1866

<sup>1</sup> Calculated or estimated values.

Table 1 - Chemical Composition and Energy Values of Poultry and Swine Feedstuffs (as fed)

Nutrient		Corn	Corn High Oil	Corn High Lysine	Corn Gluten Meal (21%)	Corn Gluten Meal (60%)
Dry Matter	%	87.11	87.12	88.43	87.93	90.95
Crude Protein (CP)	%	8.26	8.27	8.26	21.10	60.35
Coef. Dig. CP Poultry	%	87.00	88.00	87.84	77.93	93.00
Digestible CP Poultry	%	7.19	7.28	7.25	16.44	56.13
Coef. Dig. CP Swine	%	81.50	83.00	87.00	76.40	93.00
Digestible CP Swine	%	6.73	6.87	7.18	16.12	56.13
Fat	%	3.61	6.40	3.66	3.44	2.57
Coef. Dig. Fat Poultry <sup>1</sup>	%	92.00	93.00	92.00	56.00	95.00
Digestible Fat Poultry	%	3.32	5.95	3.37	1.93	2.44
Coef. Dig. Fat Swine <sup>1</sup>	%	90.00	90.00	90.00	76.40	68.02
Digestible Fat Swine	%	3.25	5.76	3.29	2.63	1.75
Linoleic acid	%	1.83	2.98	2.09	1.46	1.21
Linolenic acid	%	-	-	-	-	-
Starch	%	62.48	59.00	65.37	21.53	14.34
Crude Fiber (CF)	%	1.73	2.40	1.52	7.62	1.07
Coef. Dig. CF Swine	%	41.42	-	-	51.25	-
NDF	%	11.75	-	12.09	35.67	6.39
Coef. Dig. NDF Swine	%	66.39	-	-	55.73	73.50
ADF	%	3.54	-	3.05	10.90	8.63
Coef. Dig. ADF Swine	%	68.15	-	-	58.97	44.70
Nitrogen Free Extract (NFE)	%	72.24	68.82	73.88	49.77	25.41
Coef. Dig. NFE Poultry <sup>1</sup>	%	92.30	94.00	90.80	44.00	98.00
Digestible NFE Poultry	%	66.68	64.69	67.08	21.90	24.90
Organic Matter (OM)	%	85.84	85.90	87.32	81.93	89.40
Coef. Dig. OM Swine <sup>1</sup>	%	89.00	-	89.00	68.30	92.00
Digestible OM Swine	%	76.40	-	77.71	55.96	82.25
Ash	%	1.27	1.22	1.12	6.00	1.55
Calcium	%	0.03	0.01	0.04	0.12	0.03
Total Phosphorus (P)	%	0.24	0.28	0.20	0.75	0.44
Available P <sup>1</sup>	%	0.08	0.09	0.07	0.25	0.15
True Dig. Coef. P Swine	%	65.95	-	-	41.18	52.90
True Digestible P Swine	%	0.16	-	-	0.31	0.23
Potassium	%	0.28	0.35	0.21	1.12	0.13
Sodium	%	0.02	0.01	0.01	0.11	0.01
Chloride	%	0.05	0.05	0.05	0.21	0.05
Gross Energy	Kcal/kg	3925	4216	3907	3929	5047
Met. Energy Poultry	Kcal/kg	3381	3546	3405	1796	3696
True Met. Energy Poultry	Kcal/kg	3515	-	3579	1895	3868
Digestible Energy Swine	Kcal/kg	3460	-	3508	2700	4341
Met. Energy Swine	Kcal/kg	3340	-	3409	2560	3929
Net Energy Swine <sup>1</sup>	Kcal/kg	2645	-	2708	1778	2540

<sup>1</sup> Calculated or estimated values.

Table 1 - Chemical Composition and Energy Values of Poultry and Swine Feedstuffs (as fed)

Nutrient		Corn Germ	Corn Pre-Cooked	Cottonseed Meal (30%)	Cottonseed Meal (39%)	Fat Coconut
Dry Matter	%	89.84	88.33	89.09	89.99	99.30
Crude Protein (CP)	%	10.45	7.61	29.80	39.45	-
Coef. Dig. CP Poultry	%	88.21	89.04	76.21	78.73	-
Digestible CP Poultry	%	9.22	6.78	22.71	31.06	-
Coef. Dig. CP Swine	%	74.00	87.00	77.00	82.50	-
Digestible CP Swine	%	7.73	6.62	22.94	32.55	-
Fat	%	8.65	1.71	1.28	1.39	99.30
Coef. Dig. Fat Poultry <sup>1</sup>	%	84.00	92.00	85.00	85.00	-
Digestible Fat Poultry	%	7.27	1.57	1.08	1.18	-
Coef. Dig. Fat Swine <sup>1</sup>	%	79.00	90.00	75.64	75.64	-
Digestible Fat Swine	%	6.84	1.54	0.96	1.05	-
Linoleic acid	%	3.06	0.62	0.84	0.72	1.90
Linolenic acid	%	-	-	-	-	-
Starch	%	48.56	61.00	3.00	4.00	-
Crude Fiber (CF)	%	4.53	1.23	23.09	14.08	-
Coef. Dig. CF Swine	%	-	-	31.85	19.19	-
NDF	%	26.22	10.64	41.70	29.53	-
Coef. Dig. NDF Swine	%	-	-	43.82	17.89	-
ADF	%	7.39	2.37	30.79	16.97	-
Coef. Dig. ADF Swine	%	-	-	47.66	17.29	-
Nitrogen Free Extract (NFE)	%	62.27	76.79	29.55	28.80	-
Coef. Dig. NFE Poultry <sup>1</sup>	%	80.30	94.00	48.00	41.00	-
Digestible NFE Poultry	%	50.00	72.18	14.19	11.81	-
Organic Matter (OM)	%	85.91	87.34	83.72	83.71	99.30
Coef. Dig. OM Swine <sup>1</sup>	%	80.80	92.30	52.00	56.80	92.80
Digestible OM Swine	%	69.41	80.61	43.53	47.55	92.15
Ash	%	3.93	0.99	5.38	6.27	-
Calcium	%	0.05	0.02	0.23	0.46	-
Total Phosphorus (P)	%	0.55	0.18	0.88	1.05	-
Available P <sup>1</sup>	%	0.18	0.06	0.29	0.35	-
True Dig. Coef. P Swine	%	-	-	40.6	43.8	-
True Digestible P Swine	%	-	-	0.36	0.46	-
Potassium	%	0.62	0.25	0.59	1.34	-
Sodium	%	0.02	0.02	0.04	0.11	-
Chloride	%	0.08	-	-	0.04	-
Gross Energy	Kcal/kg	4234	3987	4130	4166	9229
Met. Energy Poultry	Kcal/kg	3144	3429	1666	1943	7924
True Met. Energy Poultry	Kcal/kg	3396	3514	1768	2173	-
Digestible Energy Swine	Kcal/kg	3355	3519	2222	2507	8565
Met. Energy Swine	Kcal/kg	3.255	3444	1996	2323	8262
Net Energy Swine <sup>1</sup>	Kcal/kg	2555	2699	1061	1328	7335

<sup>1</sup> Calculated or estimated values.



Table 1 - Chemical Composition and Energy Values of Poultry and Swine Feedstuffs (as fed)

Nutrient		Fat Lard	Fat Poultry	Fat Tallow	Feather Meal (75%)	Feather Meal (84%)
Dry Matter	%	99.55	99.60	99.39	89.64	90.71
Crude Protein (CP)	%	-	-	-	74.70	83.90
Coef. Dig. CP Poultry	%	-	-	-	70.50	69.50
Digestible CP Poultry	%	-	-	-	52.66	58.31
Coef. Dig. CP Swine	%	-	-	-	68.00	67.00
Digestible CP Swine	%	-	-	-	50.80	56.21
Fat	%	99.30	99.00	99.39	5.20	4.00
Coef. Dig. Fat Poultry <sup>1</sup>	%	-	94.40	80.00	70.00	60.00
Digestible Fat Poultry	%	-	93.40	79.51	3.64	2.40
Coef. Dig. Fat Swine <sup>1</sup>	%	-	91.50	87.10	60.00	55.00
Digestible Fat Swine	%	-	90.59	86.57	3.12	2.20
Linoleic acid	%	8.90	20.60	1.35	-	0.70
Linolenic acid	%	1.00	1.29	-	-	-
Starch	%	-	-	-	-	-
Crude Fiber (CF)	%	-	-	-	-	-
Coef. Dig. CF Swine	%	-	-	-	-	-
NDF	%	-	-	-	-	-
Coef. Dig. NDF Swine	%	-	-	-	-	-
ADF	%	-	-	-	-	-
Coef. Dig. ADF Swine	%	-	-	-	-	-
Nitrogen Free Extract (NFE)	%	-	-	-	6.86	0.70
Coef. Dig. NFE Poultry <sup>1</sup>	%	-	-	-	-	-
Digestible NFE Poultry	%	-	-	-	-	-
Organic Matter (OM)	%	99.55	99.60	99.39	86.76	88.60
Coef. Dig. OM Swine <sup>1</sup>	%	87.30	92.22	81.10	60.89	64.87
Digestible OM Swine	%	86.92	91.85	80.61	52.83	57.47
Ash	%	-	-	-	2.89	2.11
Calcium	%	-	-	-	0.36	0.29
Total Phosphorus (P)	%	-	-	-	0.67	0.74
Available P <sup>1</sup>	%	-	-	-	0.67	0.74
True Dig. Coef. P Swine	%	-	-	-	90.00	90.00
True Digestible P Swine	%	-	-	-	0.60	0.66
Potassium	%	-	-	-	0.12	0.25
Sodium	%	-	-	-	0.12	0.27
Chloride	%	-	-	-	0.19	0.25
Gross Energy	Kcal/kg	9369	9282	9408	5206	5210
Met. Energy Poultry	Kcal/kg	8080	8681	7401	2611	2734
True Met. Energy Poultry	Kcal/kg	-	9159	8116	2766	2849
Digestible Energy Swine	Kcal/kg	8180	8560	8193	3170	3380
Met. Energy Swine	Kcal/kg	7939	8228	7886	2805	2922
Net Energy Swine <sup>1</sup>	Kcal/kg	7096	7303	7061	1615	1623

<sup>1</sup> Calculated or estimated values.

Table 1 - Chemical Composition and Energy Values of Poultry and Swine Feedstuffs (as fed)

Nutrient		Feather & Poult. Byprod. Meal	Fish Meal (54%)	Fish Meal (61%)	Glucose	Lecithin
Dry Matter	%	91.52	92.26	91.63	90.37	99.36
Crude Protein (CP)	%	65.50	54.40	61.10	-	-
Coef. Dig. CP Poultry	%	77.00	86.40	87.50	-	-
Digestible CP Poultry	%	50.44	47.00	53.46	-	-
Coef. Dig. CP Swine	%	70.00	80.00	80.00	-	-
Digestible CP Swine	%	45.85	43.52	48.88	-	-
Fat	%	14.74	7.50	5.85	-	92.76
Coef. Dig. Fat Poultry <sup>1</sup>	%	79.50	86.00	86.00	-	-
Digestible Fat Poultry	%	11.72	6.49	5.03	-	-
Coef. Dig. Fat Swine <sup>1</sup>	%	70.00	83.00	75.00	-	-
Digestible Fat Swine	%	10.32	6.23	4.39	-	-
Linoleic acid	%	2.00	0.11	0.13	-	-
Linolenic acid	%	0.23	0.08	0.10	-	-
Starch	%	-	-	-	-	-
Crude Fiber (CF)	%	-	-	-	-	-
Coef. Dig. CF Swine	%	-	-	-	-	-
NDF	%	-	-	-	-	-
Coef. Dig. NDF Swine	%	-	-	-	-	-
ADF	%	-	-	-	-	-
Coef. Dig. ADF Swine	%	-	-	-	-	-
Nitrogen Free Extract (NFE)	%	4.47	7.54	5.33	90.37	0.49
Coef. Dig. NFE Poultry <sup>1</sup>	%	-	-	-	-	-
Digestible NFE Poultry	%	-	-	-	-	-
Organic Matter (OM)	%	84.71	69.44	72.28	90.37	93.25
Coef. Dig. OM Swine <sup>1</sup>	%	68.16	74.10	75.50	-	80.79
Digestible OM Swine	%	57.74	51.48	54.57	-	75.34
Ash	%	6.81	22.82	19.35	-	6.11
Calcium	%	2.56	5.90	4.70	-	-
Total Phosphorus (P)	%	1.37	2.87	2.41	-	1.60
Available P <sup>1</sup>	%	1.37	2.87	2.41	-	1.60
True Dig. Coef. P Swine	%	52.37	82.45	82.45	-	-
True Digestible P Swine	%	0.72	2.37	1.99	-	-
Potassium	%	0.35	0.60	0.58	-	-
Sodium	%	0.33	0.68	0.50	-	-
Chloride	%	0.34	0.90	0.70	-	-
Gross Energy	Kcal/kg	5235	4114	4199	4017	8188
Met. Energy Poultry	Kcal/kg	3264	2627	2778	3393	6036
True Met. Energy Poultry	Kcal/kg	3482	3065	-	-	6240
Digestible Energy Swine	Kcal/kg	3568	3050	3170	3340	6615
Met. Energy Swine	Kcal/kg	3263	2740	2845	3334	6375
Net Energy Swine <sup>1</sup>	Kcal/kg	2136	1734	1744	2434	5869

<sup>1</sup> Calculated or estimated values.

Table 1 - Chemical Composition and Energy Values of Poultry and Swine Feedstuffs (as fed)

Nutrient		Meat & Bone Meal (35%)	Meat & Bone Meal (38%)	Meat & Bone Meal (41%)	Meat & Bone Meal (45%)	Meat & Bone Meal (51%)
Dry Matter	%	92.65	93.56	92.26	92.90	93.21
Crude Protein (CP)	%	35.40	37.64	41.00	44.54	51.11
Coef. Dig. CP Poultry	%	73.00	78.40	78.50	78.80	80.00
Digestible CP Poultry	%	25.84	29.51	32.19	35.09	40.89
Coef. Dig. CP Swine	%	69.00	80.00	80.00	80.00	80.00
Digestible CP Swine	%	24.43	30.11	32.80	35.63	40.89
Fat	%	13.40	11.14	11.04	13.25	12.38
Coef. Dig. Fat Poultry <sup>1</sup>	%	47.50	58.00	54.00	76.00	76.00
Digestible Fat Poultry	%	6.37	6.46	5.96	10.07	9.41
Coef. Dig. Fat Swine <sup>1</sup>	%	33.50	32.00	42.20	44.00	38.00
Digestible Fat Swine	%	4.49	3.57	4.66	5.83	4.71
Linoleic acid	%	0.37	0.31	0.30	0.36	0.34
Linolenic acid	%	0.08	0.07	0.07	0.08	0.07
Starch	%	-	-	-	-	-
Crude Fiber (CF)	%	-	-	-	-	-
Coef. Dig. CF Swine	%	-	-	-	-	-
NDF	%	-	-	-	-	-
Coef. Dig. NDF Swine	%	-	-	-	-	-
ADF	%	-	-	-	-	-
Coef. Dig. ADF Swine	%	-	-	-	-	-
Nitrogen Free Extract (NFE)	%	1.66	3.16	1.35	4.12	2.23
Coef. Dig. NFE Poultry <sup>1</sup>	%	-	-	-	-	-
Digestible NFE Poultry	%	-	-	-	-	-
Organic Matter (OM)	%	50.46	51.93	53.38	61.91	65.73
Coef. Dig. OM Swine <sup>1</sup>	%	57.74	63.69	67.45	69.43	69.42
Digestible OM Swine	%	29.14	33.07	36.01	42.98	45.63
Ash	%	42.19	41.63	38.87	31.00	27.48
Calcium	%	15.12	11.23	10.08	9.55	9.12
Total Phosphorus (P)	%	7.92	7.85	6.80	4.96	4.66
Available P <sup>1</sup>	%	7.92	7.85	6.80	4.96	4.66
True Dig. Coef. P Swine	%	63.95	62.20	62.9	62.2	62.20
True Digestible P Swine	%	5.06	4.88	4.28	3.08	2.90
Potassium	%	0.70	0.70	0.70	0.66	0.54
Sodium	%	0.49	0.32	0.51	0.70	0.59
Chloride	%	0.50	-	0.60	0.63	0.59
Gross Energy	Kcal/kg	3122	3209	3286	3692	3964
Met. Energy Poultry	Kcal/kg	1700	1873	1937	2445	2638
True Met. Energy Poultry	Kcal/kg	1778	-	1995	-	2701
Digestible Energy Swine	Kcal/kg	1803	2044	2296	2564	2752
Met. Energy Swine	Kcal/kg	1618	1820	2065	2332	2485
Net Energy Swine <sup>1</sup>	Kcal/kg	1120	1222	1377	1578	1634

<sup>1</sup> Calculated or estimated values.

Table 1 - Chemical Composition and Energy Values of Poultry and Swine Feedstuffs (as fed)

Nutrient		Meat & Bone Meal (55%)	Meat & Bone meal (60%)	Milk Skimmed Dried	Milk Whey Dried	Millet
Dry Matter	%	93.28	94.07	93.93	95.49	89.64
Crude Protein (CP)	%	54.58	60.10	33.62	12.05	13.10
Coef. Dig. CP Poultry	%	82.00	82.00	-	93.00	92.30
Digestible CP Poultry	%	44.75	49.28	-	11.21	12.09
Coef. Dig. CP Swine	%	81.00	81.50	95.11	92.00	74.01
Digestible CP Swine	%	44.21	48.98	31.98	11.09	9.70
Fat	%	9.80	10.49	0.73	0.90	4.22
Coef. Dig. Fat Poultry <sup>1</sup>	%	80.00	68.50	-	-	75.00
Digestible Fat Poultry	%	7.84	7.19	-	-	3.16
Coef. Dig. Fat Swine <sup>1</sup>	%	38.00	35.00	95.00	95.00	70.00
Digestible Fat Swine	%	3.72	3.67	0.69	0.86	2.95
Linoleic acid	%	0.27	0.29	0.02	0.02	1.63
Linolenic acid	%	0.06	0.06	-	-	-
Starch	%	-	-	-	-	63.29
Crude Fiber (CF)	%	-	-	-	-	4.19
Coef. Dig. CF Swine	%	-	-	-	-	-
NDF	%	-	-	-	-	19.33
Coef. Dig. NDF Swine	%	-	-	-	-	-
ADF	%	-	-	-	-	9.66
Coef. Dig. ADF Swine	%	-	-	-	-	-
Nitrogen Free Extract (NFE)	%	2.99	1.72	51.88	74.09	66.55
Coef. Dig. NFE Poultry <sup>1</sup>	%	-	-	-	-	85.50
Digestible NFE Poultry	%	-	-	-	-	56.90
Organic Matter (OM)	%	67.37	72.31	86.23	87.04	88.06
Coef. Dig. OM Swine <sup>1</sup>	%	70.85	71.71	92.00	90.00	72.50
Digestible OM Swine	%	47.73	51.85	79.33	78.34	63.84
Ash	%	25.91	21.76	7.70	8.45	1.58
Calcium	%	8.46	7.54	1.17	0.75	0.03
Total Phosphorus (P)	%	4.18	3.80	0.68	0.68	0.25
Available P <sup>1</sup>	%	4.18	3.80	0.68	0.68	0.08
True Dig. Coef. P Swine	%	62.20	62.20	-	95.50	-
True Digestible P Swine	%	2.60	2.36	-	0.7	-
Potassium	%	0.50	0.47	1.47	2.08	0.34
Sodium	%	0.70	0.60	0.41	0.79	0.01
Chloride	%	0.57	0.55	0.90	1.34	0.03
Gross Energy	Kcal/kg	4017	4341	4163	3675	3894
Met. Energy Poultry	Kcal/kg	2656	2791	2781	-	3168
True Met. Energy Poultry	Kcal/kg	2710	2872	-	-	3354
Digestible Energy Swine	Kcal/kg	2846	3113	3805	3449	2945
Met. Energy Swine	Kcal/kg	2580	2798	3502	3322	2872
Net Energy Swine <sup>1</sup>	Kcal/kg	1646	1777	2341	2356	2258

<sup>1</sup> Calculated or estimated values.

Table 1 - Chemical Composition and Energy Values of Poultry and Swine Feedstuffs (as fed)

Nutrient		Oil Canola	Oil Corn	Oil Palm	Oil Soybean	Palm Ouricuri Meal
Dry Matter	%	99.50	99.25	99.50	99.60	90.00
Crude Protein (CP)	%	-	-	-	-	23.00
Coef. Dig. CP Poultry	%	-	-	-	-	-
Digestible CP Poultry	%	-	-	-	-	-
Coef. Dig. CP Swine	%	-	-	-	-	-
Digestible CP Swine	%	-	-	-	-	-
Fat	%	99.50	99.00	99.40	99.60	0.82
Coef. Dig.Fat Poultry <sup>1</sup>	%	95.00	95.10	-	95.00	-
Digestible Fat Poultry	%	94.53	94.15	-	94.62	-
Coef. Dig. Fat Swine <sup>1</sup>	%	91.80	91.80	-	91.50	-
Digestible Fat Swine	%	91.34	90.88	-	91.13	-
Linoleic acid	%	20.70	53.40	10.25	53.93	-
Linolenic acid	%	9.80	0.70	-	7.00	-
Starch	%	-	-	-	-	-
Crude Fiber (CF)	%	-	-	-	-	17.60
Coef. Dig. CF Swine	%	-	-	-	-	-
NDF	%	-	-	-	-	-
Coef. Dig. NDF Swine	%	-	-	-	-	-
ADF	%	-	-	-	-	-
Coef. Dig. ADF Swine	%	-	-	-	-	-
Nitrogen Free Extract (NFE)	%	-	-	-	-	42.26
Coef. Dig.NFE Poultry <sup>1</sup>	%	-	-	-	-	-
Digestible NFE Poultry	%	-	-	-	-	-
Organic Matter (OM)	%	99.50	99.25	99.50	99.60	83.68
Coef. Dig. OM Swine <sup>1</sup>	%	91.80	90.00	85.21	92.15	-
Digestible OM Swine	%	91.34	89.33	84.79	91.78	-
Ash	%	-	-	-	-	6.32
Calcium	%	-	-	-	-	0.10
Total Phosphorus (P)	%	-	-	-	-	0.70
Available P <sup>1</sup>	%	-	-	-	-	0.23
True Dig. Coef. P Swine	%	-	-	-	-	-
True Digestible P Swine	%	-	-	-	-	-
Potassium	%	-	-	-	-	0.62
Sodium	%	-	-	-	-	0.03
Chloride	%	-	-	-	-	-
Gross Energy	Kcal/kg	9399	9350	9400	9333	-
Met. Energy Poultry	Kcal/kg	8784	8773	8817	8790	1431
True Met. Energy Poultry	Kcal/kg	9130	9250	-	9200	-
Digestible Energy Swine	Kcal/kg	8630	8580	8010	8600	1982
Met. Energy Swine	Kcal/kg	8455	8280	7690	8300	1766
Net Energy Swine <sup>1</sup>	Kcal/kg	7476	7341	6916	7364	975

<sup>1</sup> Calculated or estimated values.

Table 1 - Chemical Composition and Energy Values of Poultry and Swine Feedstuffs (as fed)

Nutrient		Passion Fruit Pulp Dried	Pasta - Spaghetti Residue	Peanut meal	Poultry By-Product Meal	Poultry By-Prod. Meal High Fat
Dry Matter	%	90.69	88.02	89.55	92.24	93.90
Crude Protein (CP)	%	12.42	12.37	48.45	57.00	55.30
Coef. Dig. CP Poultry	%	81.44	90.22	85.00	84.00	82.71
Digestible CP Poultry	%	10.12	11.16	41.18	47.88	45.74
Coef. Dig. CP Swine	%	-	-	90.50	82.00	82.60
Digestible CP Swine	%	-	-	43.85	46.74	45.68
Fat	%	6.04	1.17	1.02	13.84	20.58
Coef. Dig. Fat Poultry <sup>1</sup>	%	-	-	83.00	93.00	89.60
Digestible Fat Poultry	%	-	-	0.85	12.87	18.44
Coef. Dig. Fat Swine <sup>1</sup>	%	-	-	55.00	96.10	94.00
Digestible Fat Swine	%	-	-	0.56	13.30	19.35
Linoleic acid	%	-	0.46	0.28	1.90	3.35
Linolenic acid	%	-	-	-	-	-
Starch	%	-	-	-	-	-
Crude Fiber (CF)	%	34.85	2.00	7.70	-	-
Coef. Dig. CF Swine	%	-	-	-	-	-
NDF	%	68.04	1.30	15.45	-	-
Coef. Dig. NDF Swine	%	-	-	-	-	-
ADF	%	64.92	0.60	10.55	-	-
Coef. Dig. ADF Swine	%	-	-	-	-	-
Nitrogen Free Extract (NFE)	%	36.24	71.13	26.43	6.45	6.42
Coef. Dig. NFE Poultry <sup>1</sup>	%	-	-	39.00	-	-
Digestible NFE Poultry	%	-	-	10.31	-	-
Organic Matter (OM)	%	89.55	86.66	83.59	77.29	82.30
Coef. Dig. OM Swine <sup>1</sup>	%	-	-	80.60	83.92	82.56
Digestible OM Swine	%	-	-	67.37	64.86	67.94
Ash	%	1.14	1.36	5.96	14.95	11.60
Calcium	%	-	0.08	0.17	4.00	3.64
Total Phosphorus (P)	%	-	0.13	0.63	2.66	1.88
Available P <sup>1</sup>	%	-	0.04	0.21	2.66	1.88
True Dig. Coef. P Swine	%	-	-	-	52.40	52.40
True Digestible P Swine	%	-	-	0.17	1.39	0.99
Potassium	%	-	0.18	1.28	0.53	0.53
Sodium	%	-	0.01	0.03	0.39	0.51
Chloride	%	-	-	0.07	0.51	0.51
Gross Energy	Kcal/kg	5435	3790	4313	4661	5343
Met. Energy Poultry	Kcal/kg	3284	3445	2278	3259	3682
True Met. Energy Poultry	Kcal/kg	-	-	2396	3579	3850
Digestible Energy Swine	Kcal/kg	-	-	3475	3905	4411
Met. Energy Swine	Kcal/kg	-	-	3178	3566	4106
Net Energy Swine <sup>1</sup>	Kcal/kg	-	-	1934	2403	2896

<sup>1</sup> Calculated or estimated values.

Table 1 - Chemical Composition and Energy Values of Poultry and Swine Feedstuffs (as fed)

Nutrient		Red Blood Cells	Rice Broken	Rice Bran	Rice Bran Defatted	Sorghum High Tannin
Dry Matter	%	90.40	88.04	89.30	89.60	85.88
Crude Protein (CP)	%	84.10	8.47	13.24	15.50	8.94
Coef. Dig. CP Poultry	%	94.00	81.00	77.67	77.61	68.00
Digestible CP Poultry	%	79.74	6.86	10.28	12.03	6.08
Coef. Dig. CP Swine	%	90.00	88.10	74.44	74.00	73.30
Digestible CP Swine	%	75.69	7.46	9.86	11.47	6.55
Fat	%	0.51	1.22	14.81	1.65	2.35
Coef. Dig. Fat Poultry <sup>1</sup>	%	-	88.00	62.00	62.00	83.00
Digestible Fat Poultry	%	-	1.08	9.18	1.02	1.95
Coef. Dig. Fat Swine <sup>1</sup>	%	85.00	84.97	80.00	70.00	75.00
Digestible Fat Swine	%	0.43	1.04	11.85	1.16	1.76
Linoleic acid	%	-	0.35	2.37	0.49	1.13
Linolenic acid	%	-	0.20	0.02	-	-
Starch	%	-	74.45	22.70	26.00	56.80
Crude Fiber (CF)	%	-	0.55	7.88	10.86	2.78
Coef. Dig. CF Swine	%	-	-	39.72	39.72	-
NDF	%	-	4.28	21.30	24.30	9.80
Coef. Dig. NDF Swine	%	-	14.46	50.65	50.65	-
ADF	%	-	7.43	12.58	15.80	4.60
Coef. Dig. ADF Swine	%	-	92.99	52.86	52.86	-
Nitrogen Free Extract (NFE)	%	1.90	76.83	44.55	51.51	69.95
Coef. Dig. NFE Poultry <sup>1</sup>	%	-	91.80	67.00	56.00	86.50
Digestible NFE Poultry	%	-	70.53	29.85	28.85	60.51
Organic Matter (OM)	%	86.51	87.07	80.48	79.52	84.02
Coef. Dig. OM Swine <sup>1</sup>	%	83.87	94.80	72.10	69.80	83.00
Digestible OM Swine	%	72.55	82.54	58.03	55.50	69.74
Ash	%	3.89	0.97	8.82	10.08	1.86
Calcium	%	0.03	0.04	0.11	0.10	0.03
Total Phosphorus (P)	%	0.18	0.16	1.61	1.81	0.26
Available P <sup>1</sup>	%	0.18	0.05	0.32	0.36	0.09
True Dig. Coef. P Swine	%	-	-	-	-	-
True Digestible P Swine	%	-	-	-	-	-
Potassium	%	0.30	0.19	1.40	1.59	0.31
Sodium	%	0.60	0.02	0.04	0.04	0.01
Chloride	%	0.80	0.04	0.06	0.07	0.01
Gross Energy	Kcal/kg	5008	3846	4394	3740	3860
Met. Energy Poultry	Kcal/kg	3382	3315	2534	1808	2956
True Met. Energy Poultry	Kcal/kg	-	3507	3143	-	3037
Digestible Energy Swine	Kcal/kg	4300	3595	3179	2531	3081
Met. Energy Swine	Kcal/kg	3787	3491	3111	2450	2984
Net Energy Swine <sup>1</sup>	Kcal/kg	2208	2778	2384	1697	2318

<sup>1</sup> Calculated or estimated values.

Table 1 - Chemical Composition and Energy Values of Poultry and Swine Feedstuffs (as fed)

Nutrient		Sorghum Low Tannin	Soybean Hulls	Soybean Protein Concentrate	Soybean Meal (45%)	Soybean Meal (48%)
Dry Matter	%	87.97	88.80	89.88	88.59	88.21
Crude Protein (CP)	%	9.23	13.50	62.92	45.32	47.90
Coef. Dig. CP Poultry	%	86.00	63.90	90.00	91.90	92.12
Digestible CP Poultry	%	7.94	8.63	56.63	41.65	44.13
Coef. Dig. CP Swine	%	81.00	63.20	92.65	90.00	91.00
Digestible CP Swine	%	7.48	8.53	58.29	40.79	43.59
Fat	%	3.00	2.86	0.43	1.66	1.40
Coef. Dig. Fat Poultry <sup>1</sup>	%	83.00	-	50.00	50.00	50.00
Digestible Fat Poultry	%	2.49	-	0.21	0.83	0.70
Coef. Dig. Fat Swine <sup>1</sup>	%	75.20	70.00	65.00	63.00	65.00
Digestible Fat Swine	%	2.25	2.01	0.28	1.05	0.91
Linoleic acid	%	1.05	1.11	0.28	0.67	0.65
Linolenic acid	%	-	-	-	0.09	0.09
Starch	%	60.79	-	-	12.38	3.00
Crude Fiber (CF)	%	2.30	33.00	2.64	5.41	4.27
Coef. Dig. CF Swine	%	75.49	-	-	68.60	68.60
NDF	%	10.03	57.20	10.56	13.86	14.93
Coef. Dig. NDF Swine	%	73.21	-	-	82.60	82.60
ADF	%	5.90	44.15	6.61	8.16	12.28
Coef. Dig. ADF Swine	%	85.40	-	-	77.71	77.70
Nitrogen Free Extract (NFE)	%	72.05	34.83	19.06	30.29	28.91
Coef. Dig. NFE Poultry <sup>1</sup>	%	87.80	-	28.00	30.50	28.00
Digestible NFE Poultry	%	63.26	-	5.34	9.24	8.10
Organic Matter (OM)	%	86.59	84.19	85.05	82.69	82.49
Coef. Dig. OM Swine <sup>1</sup>	%	86.90	61.50	89.20	80.40	83.00
Digestible OM Swine	%	75.24	51.78	75.86	66.48	68.46
Ash	%	1.39	4.61	4.83	5.90	5.72
Calcium	%	0.03	0.49	0.27	0.24	0.31
Total Phosphorus (P)	%	0.26	0.14	0.81	0.53	0.65
Available P <sup>1</sup>	%	0.09	0.05	0.27	0.18	0.21
True Dig. Coef. P Swine	%	65.40	-	38.56	52.00	52.00
True Digestible P Swine	%	0.17	-	0.31	0.28	0.34
Potassium	%	0.34	-	2.18	1.83	2.11
Sodium	%	0.02	-	0.05	0.02	0.02
Chloride	%	0.05	-	-	0.05	0.05
Gross Energy	Kcal/kg	3928	3854	4495	4079	4164
Met. Energy Poultry	Kcal/kg	3192	871	2677	2256	2302
True Met. Energy Poultry	Kcal/kg	3481	-	2870	2486	2590
Digestible Energy Swine	Kcal/kg	3348	2370	4035	3425	3540
Met. Energy Swine	Kcal/kg	3289	2245	3602	3154	3253
Net Energy Swine <sup>1</sup>	Kcal/kg	2581	1266	2188	2014	2042

<sup>1</sup> Calculated or estimated values.



Table 1 - Chemical Composition and Energy Values of Poultry and Swine Feedstuffs (as fed)

Nutrient		Soybean Full-Fat Extruded	Soybean Full-Fat Toasted	Soybean Full-Fat Micronized	Starch	Sugar
Dry Matter	%	90.47	90.27	92.62	87.69	99.93
Crude Protein (CP)	%	37.00	37.00	39.14	-	-
Coef. Dig. CP Poultry	%	90.00	87.00	90.00	-	-
Digestible CP Poultry	%	33.30	32.19	35.23	-	-
Coef. Dig. CP Swine	%	89.00	82.00	88.00	-	-
Digestible CP Swine	%	32.93	30.34	34.44	-	-
Fat	%	17.64	17.86	21.50	-	-
Coef. Dig. Fat Poultry <sup>1</sup>	%	94.00	85.40	86.00	-	-
Digestible Fat Poultry	%	16.58	15.25	18.49	-	-
Coef. Dig. Fat Swine <sup>1</sup>	%	82.00	78.00	81.00	-	-
Digestible Fat Swine	%	14.46	13.93	17.42	-	-
Linoleic acid	%	9.45	9.45	10.60	-	-
Linolenic acid	%	1.32	1.35	1.61	-	-
Starch	%	6.70	6.70	6.70	87.69	-
Crude Fiber (CF)	%	6.24	6.20	1.36	-	-
Coef. Dig. CF Swine	%	76.60	76.60	77.65	-	-
NDF	%	15.70	15.70	29.31	-	-
Coef. Dig. NDF Swine	%	76.70	76.70	98.32	-	-
ADF	%	11.40	11.40	5.86	-	-
Coef. Dig. ADF Swine	%	85.10	85.10	82.55	-	-
Nitrogen Free Extract (NFE)	%	24.99	24.61	26.15	87.69	99.79
Coef. Dig. NFE Poultry <sup>1</sup>	%	44.00	47.00	40.00	100.00	93.00
Digestible NFE Poultry	%	11.00	11.57	10.46	87.69	92.81
Organic Matter (OM)	%	85.87	85.67	88.15	87.69	99.79
Coef. Dig. OM Swine <sup>1</sup>	%	84.00	77.00	86.00	100.00	93.80
Digestible OM Swine	%	72.13	65.96	75.81	87.69	93.60
Ash	%	4.60	4.60	4.47	-	0.14
Calcium	%	0.23	0.23	0.22	-	-
Total Phosphorus (P)	%	0.52	0.52	0.51	-	-
Available P <sup>1</sup>	%	0.17	0.17	0.17	-	-
True Dig. Coef. P Swine	%	50.10	50.10	50.10	-	-
True Digestible P Swine	%	0.26	0.26	0.26	-	-
Potassium	%	1.67	1.64	1.65	-	-
Sodium	%	0.01	0.01	0.01	-	-
Chloride	%	0.02	0.02	0.03	-	-
Gross Energy	Kcal/kg	4938	4938	5279	3821	4008
Met. Energy Poultry	Kcal/kg	3429	3281	3660	3625	3831
True Met. Energy Poultry	Kcal/kg	3538	3454	4171	3771	3887
Digestible Energy Swine	Kcal/kg	4250	3930	4583	3648	3873
Met. Energy Swine	Kcal/kg	4000	3706	4330	3520	3737
Net Energy Swine <sup>1</sup>	Kcal/kg	2867	2656	3192	2894	2729

<sup>1</sup> Calculated or estimated values.

Table 1 - Chemical Composition and Energy Values of Poultry and Swine Feedstuffs (as fed)

Nutrient		Sugarcane Juice	Sugarcane Molasses	Sugarcane Molasses Dried	Sweet Potato Dried	Swine By- Product Meal
Dry Matter	%	18.55	73.98	93.26	88.72	92.93
Crude Protein (CP)	%	0.30	3.66	2.44	3.87	44.50
Coef. Dig. CP Poultry	%	-	-	-	-	87.33
Digestible CP Poultry	%	-	-	-	-	38.86
Coef. Dig. CP Swine	%	-	-	-	30.00	78.60
Digestible CP Swine	%	-	-	-	1.16	34.98
Fat	%	-	0.10	-	0.91	14.57
Coef. Dig. Fat Poultry <sup>1</sup>	%	-	-	-	-	-
Digestible Fat Poultry	%	-	-	-	-	-
Coef. Dig. Fat Swine <sup>1</sup>	%	-	-	-	70.00	-
Digestible Fat Swine	%	-	-	-	0.63	-
Linoleic acid	%	-	-	-	-	-
Linolenic acid	%	-	-	-	-	-
Starch	%	-	-	-	62.90	-
Crude Fiber (CF)	%	0.05	2.46	6.20	2.69	-
Coef. Dig. CF Swine	%	-	-	-	-	-
NDF	%	-	-	-	8.80	-
Coef. Dig. NDF Swine	%	-	-	-	-	-
ADF	%	-	-	-	3.60	-
Coef. Dig. ADF Swine	%	-	-	-	-	-
Nitrogen Free Extract (NFE)	%	17.90	59.02	68.32	78.26	6.33
Coef. Dig. NFE Poultry <sup>1</sup>	%	-	-	-	-	-
Digestible NFE Poultry	%	-	-	-	-	-
Organic Matter (OM)	%	18.25	65.23	76.96	85.72	65.40
Coef. Dig. OM Swine <sup>1</sup>	%	93.39	-	-	91.50	-
Digestible OM Swine	%	17.04	-	-	78.43	-
Ash	%	0.30	8.75	16.30	3.00	27.52
Calcium	%	0.01	0.76	6.21	0.10	7.64
Total Phosphorus (P)	%	0.02	0.06	0.21	0.16	4.78
Available P <sup>1</sup>	%	0.01	0.02	0.07	0.05	4.78
True Dig. Coef. P Swine	%	-	-	-	-	-
True Digestible P Swine	%	-	-	-	-	-
Potassium	%	-	3.25	2.19	0.65	-
Sodium	%	-	0.58	0.15	0.15	-
Chloride	%	-	1.38	-	0.09	-
Gross Energy	Kcal/kg	757	2850	3170	3875	4006
Met. Energy Poultry	Kcal/kg	-	1880	2153	2706	2114
True Met. Energy Poultry	Kcal/kg	-	2230	2480	2519	-
Digestible Energy Swine	Kcal/kg	707	2403	2616	3305	-
Met. Energy Swine	Kcal/kg	675	2345	2495	3284	-
Net Energy Swine <sup>1</sup>	Kcal/kg	490	1665	1745	2590	-

<sup>1</sup> Calculated or estimated values.

Table 1 - Chemical Composition and Energy Values of Poultry and Swine Feedstuffs (as fed)

Nutrient		Triticale	Wheat	Wheat Bran-Midds	Wheat Flour	Wheat Shorts
Dry Matter	%	88.23	87.77	88.00	86.93	88.19
Crude Protein (CP)	%	12.23	11.49	15.52	12.26	17.52
Coef. Dig. CP Poultry	%	86.60	87.50	78.00	93.40	84.00
Digestible CP Poultry	%	10.59	10.05	12.11	11.45	14.72
Coef. Dig. CP Swine	%	83.60	86.80	77.40	-	78.00
Digestible CP Swine	%	10.22	9.97	12.01	-	13.67
Fat	%	1.51	1.68	3.46	1.70	2.63
Coef. Dig. Fat Poultry <sup>1</sup>	%	67.00	68.00	65.00	87.00	87.00
Digestible Fat Poultry	%	1.01	1.14	2.25	1.48	2.28
Coef. Dig. Fat Swine <sup>1</sup>	%	70.00	70.00	89.30	-	80.00
Digestible Fat Swine	%	1.06	1.17	3.09	-	2.10
Linoleic acid	%	0.54	0.68	1.54	0.54	1.46
Linolenic acid	%	-	-	-	-	-
Starch	%	55.25	54.93	31.35	76.50	27.74
Crude Fiber (CF)	%	2.61	2.37	9.66	-	7.59
Coef. Dig. CF Swine	%	-	-	36.08	-	-
NDF	%	12.45	12.26	40.59	2.65	31.48
Coef. Dig. NDF Swine	%	-	-	50.44	-	-
ADF	%	3.95	3.19	13.85	-	9.57
Coef. Dig. ADF Swine	%	-	-	52.40	-	-
Nitrogen Free Extract (NFE)	%	70.24	70.64	54.56	72.51	56.35
Coef. Dig. NFE Poultry <sup>1</sup>	%	85.30	85.80	48.30	95.60	63.20
Digestible NFE Poultry	%	59.91	60.61	26.35	69.31	35.61
Organic Matter (OM)	%	86.59	86.18	83.20	86.47	84.08
Coef. Dig. OM Swine <sup>1</sup>	%	85.60	88.00	64.00	-	72.50
Digestible OM Swine	%	74.12	75.84	53.25	-	60.96
Ash	%	1.64	1.59	4.79	0.47	4.11
Calcium	%	0.04	0.05	0.14	0.11	0.14
Total Phosphorus (P)	%	0.29	0.32	0.99	0.08	0.90
Available P <sup>1</sup>	%	0.10	0.10	0.33	0.02	0.30
True Dig. Coef. P Swine	%	-	-	55.60	-	-
True Digestible P Swine	%	-	-	0.55	-	-
Potassium	%	0.44	0.40	1.03	0.11	1.00
Sodium	%	0.02	0.01	0.02	0.01	0.03
Chloride	%	0.03	0.07	0.06	-	0.04
Gross Energy	Kcal/kg	3853	3819	3919	3775	3798
Met. Energy Poultry	Kcal/kg	3031	3046	1824	3503	2321
True Met. Energy Poultry	Kcal/kg	3165	3124	2119	3551	2333
Digestible Energy Swine	Kcal/kg	3278	3351	2551	-	2848
Met. Energy Swine	Kcal/kg	3181	3260	2442	-	2740
Net Energy Swine <sup>1</sup>	Kcal/kg	2446	2505	1746	-	1946

<sup>1</sup> Calculated or estimated values.

Table 1 - Chemical Composition and Energy Values of Poultry and Swine Feedstuffs (as fed)

Nutrient		Wheat Germ	Wheat Screenings	Yeast Alcohol Distillery	Yeast Brewery
Dry Matter	%	88.27	88.17	90.85	87.36
Crude Protein (CP)	%	28.29	13.61	36.75	42.60
Coef. Dig. CP Poultry	%	89.00	86.00	47.72	61.00
Digestible CP Poultry	%	25.18	11.70	17.54	25.99
Coef. Dig. CP Swine	%	86.00	82.00	75.12	79.00
Digestible CP Swine	%	24.33	11.16	27.61	33.65
Fat	%	9.19	2.11	0.48	2.30
Coef. Dig. Fat Poultry <sup>1</sup>	%	64.00	60.00	57.00	75.00
Digestible Fat Poultry	%	5.88	1.26	0.27	1.73
Coef. Dig. Fat Swine <sup>1</sup>	%	60.00	70.00	80.00	82.00
Digestible Fat Swine	%	5.51	1.47	0.38	1.89
Linoleic acid	%	3.43	0.79	-	-
Linolenic acid	%	-	-	-	-
Starch	%	15.45	-	-	1.00
Crude Fiber (CF)	%	2.50	6.55	0.50	1.90
Coef. Dig. CF Swine	%	-	-	-	-
NDF	%	9.58	18.71	-	6.20
Coef. Dig. NDF Swine	%	-	-	-	-
ADF	%	3.65	8.85	-	1.80
Coef. Dig. ADF Swine	%	-	-	-	-
Nitrogen Free Extract (NFE)	%	44.16	63.15	49.76	36.61
Coef. Dig. NFE Poultry <sup>1</sup>	%	49.50	82.60	83.70	87.00
Digestible NFE Poultry	%	21.86	52.16	41.65	31.85
Organic Matter (OM)	%	84.13	85.41	87.49	83.41
Coef. Dig. OM Swine <sup>1</sup>	%	87.30	81.80	81.00	83.00
Digestible OM Swine	%	73.45	69.87	70.87	69.23
Ash	%	4.14	2.76	3.36	3.95
Calcium	%	0.09	0.12	0.29	0.26
Total Phosphorus (P)	%	0.88	0.43	0.82	0.78
Available P <sup>1</sup>	%	0.29	0.14	0.27	0.26
True Dig. Coef. P Swine	%	-	-	66.45	-
True Digestible P Swine	%	-	-	0.5	-
Potassium	%	0.73	0.43	1.13	1.32
Sodium	%	0.01	0.02	0.20	0.19
Chloride	%	0.07	-	-	-
Gross Energy	Kcal/kg	4343	3875	4157	4262
Met. Energy Poultry	Kcal/kg	2536	2783	2506	2600
True Met. Energy Poultry	Kcal/kg	2718	-	2615	-
Digestible Energy Swine	Kcal/kg	3700	3141	3370	3474
Met. Energy Swine	Kcal/kg	3578	3027	3164	3240
Net Energy Swine <sup>1</sup>	Kcal/kg	2576	2083	2065	2095

<sup>1</sup> Calculated or estimated values.

Table 2 - Equations to Estimate the Metabolizable Energy of Feedstuffs for Poultry

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**Vegetable / Plant Feedstuffs**

$$\text{MEn} = 4.31 \text{ CPd} + 9.29 \text{ Fd} + 4.14 \text{ NFEd}$$

**Animal By-Product, Fat and Oil Feedstuffs**

$$\text{MEn} = 4.31 \text{ CPd} + 9.29 \text{ Fd}$$

MEn = Metabolizable energy Poultry, kcal/kg.

CPd = Digestible Protein Poultry, g/kg

Fd = Digestible Fat Poultry, g/kg

NFEd = Digestible Nitrogen Free Extract Poultry, g/kg

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Janssen, W. M. European Table of Energy Values for Poultry Feedstuffs. Wageningen, The Netherlands. 1989, 104p.

Titus, H. W. Alimentación Científica de las Gallinas. Ed. Acribia, Spain. 1960, 290p.

Table 3 - Equations to Estimate Energy Values of Feedstuffs for Swine

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**DIGESTIBLE ENERGY****Vegetable / Plant Feedstuffs and Milk Products**

$$DE = 5.65 \text{ CPd} + 9.45 \text{ Fd} + 4.14 (\text{OMd} - \text{CPd} - \text{Fd})$$

**Animal By-Product, Fat and Oil Feedstuffs**

$$DE = 5.65 \text{ CPd} + 9.45 \text{ Fd}$$

**METABOLIZABLE ENERGY****Vegetable / Plant Feedstuffs and Milk Products**

$$ME = 4.952 \text{ CPd} + 9.45 \text{ Fd} + 4.14 (\text{OMd} - \text{CPd} - \text{Fd})$$

**Animal by-Product Feedstuffs**

$$ME = 4.952 \text{ CPd} + 9.45 \text{ Fd}$$

**Fat, Oil and Carbohydrate Feedstuffs**

$$ME = 0.965 \text{ DE}$$

**NET ENERGY**

$$NE = 0.73 \text{ ME} + 13.1 \text{ F} + 3.7 \text{ S} - 6.7 \text{ CP} - 9.7 \text{ CF}$$

DE = Dig. Energy Swine, kcal/kg

ME = Metab Energy. Swine, kcal/kg

CPd = Dig. Protein Swine, g/kg

Fd = Dig. Fat Swine, g/kg

OMd = Dig. Organic Mat.Swine, g/kg

NE = Net Energy Swine, kcal/kg

F = Fat, %

S = Starch, %

CP = Crude protein, %

CF = Crude Fiber, %

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Coutinho, R. *Noções de Fisiologia da Nutrição*. Ed. O Cruzeiro. Rio de Janeiro. 1966, 471p.Sauvant, D., Perez, J. M. and Tran, G. (Editores Científicos). *Tablas de Composición y de Valor Nutritivo de las Materias Primas Destinadas a los Animales de Interés Ganadero*. Ed. Mundi-Prensa. Spain. 2004, 310p.

Table 4 - Equation to Estimate Metabolizable Energy Lost (MEL) for Poultry as a Function of Corn Grading / Type

$$\text{MEL} = -0.064 + 1.62 \text{ BRK} + 6.98 \text{ FRIM} + 10.06 \text{ MOLD} + 12.28 \text{ INS} + 5.87 \text{ ADC}$$

MEL = Metabolizable Energy Lost for Poultry, Kcal/kg.

BRK = Broken Grains, %

FRIM = Fragmented Grains and Impurities, %

MOLD = Grains Contaminated by Molds, %

INS = Grains Attacked by Insects, %

ADC = Grains Affected by Different Causes, %

Example:

Grading/Type	"0"	I <sup>1</sup>	II <sup>1</sup>	III <sup>1</sup>
BRK, %	0	0.16	1.32	5.88
FRIM, %	0	0	1.18	1.96
MOLD, %	0	2.60	3.64	6.32
INS, %	0	0.24	0.12	0.16
ADC, %%	0	0	0	0
MEL Eq., Kcal/kg	0	- 29	- 51	- 89
ME poultry, Kcal/kg	3432 <sup>2</sup>	3403	3381 <sup>2</sup>	3343

<sup>1</sup> Grading by the Ministry of Agriculture.

<sup>2</sup> Considering Type II Corns with 3381 Kcal/kg (Table 1), Corn with 0 % de BRK, FRIM, MOLD, INS and ADC has MEL = 0, then the ME poultry is 3381 + 51 = 3432 Kcal/kg.

Table 5 - Total and Digestible Amino Acid Content of Poultry and Swine Feedstuffs (as fed)

Nutrient		Bakery - Cracker Residue		Blood Plasma		Blood Meal		Canola Meal		Carob Meal	
Total Amino Acid											
		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>	
Crude protein	%	8.56		72.20		82.80		37.58		8.79	
Lysine	%	0.21		6.69		7.52		2.03		0.28	
Methionine	%	0.13		1.03		1.03		0.79		0.07	
Met + Cys	%	0.32		3.08		1.82		1.64		-	
Tryptophan	%	0.10		1.26		1.46		0.48		0.05	
Threonine	%	0.27		4.40		4.15		1.58		0.27	
Arginine	%	0.35		3.88		3.46		2.37		0.43	
Gli + Ser	%	0.78		7.07		8.20		3.46		-	
Valine	%	0.38		4.97		7.33		1.85		0.54	
Isoleucine	%	0.31		2.27		0.70		1.60		0.26	
Leucine	%	0.61		7.13		10.94		2.66		0.59	
Histidine	%	0.20		2.14		5.05		1.00		0.12	
Phenylalanine	%	0.40		4.10		6.12		1.43		0.20	
Phe + Tyr	%	0.58		7.19		8.50		2.27		0.47	
True Digestible Amino Acid - Poultry											
		Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>
Lysine	%	0.14	66.2	6.16	92.2	5.80	77.2	1.77	87.3	-	-
Methionine	%	0.11	83.3	0.93	90.0	0.83	80.4	0.72	90.7	-	-
Met + Cys	%	0.25	76.6	2.79	90.7	1.31	72.2	1.50	91.6	-	-
Tryptophan	%	0.07	78.9	1.13	89.6	1.13	77.1	0.42	86.2	-	-
Threonine	%	0.17	62.7	3.98	90.4	3.32	79.9	1.31	82.8	-	-
Arginine	%	0.29	83.9	3.64	93.8	2.73	78.8	2.15	90.7	-	-
Valine	%	0.30	78.7	4.48	90.2	5.65	77.1	1.59	85.8	-	-
Isoleucine	%	0.26	84.0	2.02	88.7	0.46	65.4	1.25	78.0	-	-
Leucine	%	0.53	87.1	6.53	91.6	8.70	79.5	2.15	81.1	-	-
Histidine	%	0.15	75.7	1.95	91.2	3.97	78.8	0.90	89.4	-	-
Phenylalanine	%	0.35	88.0	3.82	93.2	4.98	81.4	1.24	87.0	-	-
Phe +Tyr	%	0.50	85.5	6.89	95.8	5.76	67.7	1.91	84.4	-	-
True Digestible Amino Acid - Swine											
Lysine	%	0.18	84.0	6.40	95.7	5.82	77.3	-	-	-	-
Methionine	%	0.12	86.7	0.95	92.3	0.79	76.4	-	-	-	-
Met + Cys	%	0.28	86.1	2.84	92.2	1.39	76.2	-	-	-	-
Tryptophan	%	0.07	78.9	1.14	90.2	1.11	76.1	-	-	-	-
Threonine	%	-	-	4.05	92.0	3.04	73.3	-	-	-	-
Arginine	%	-	-	3.78	97.3	2.67	77.0	-	-	-	-
Valine	%	0.34	87.8	4.61	92.8	5.14	70.2	-	-	-	-
Isoleucine	%	0.27	88.2	2.08	91.5	0.56	79.9	-	-	-	-
Leucine	%	-	-	6.73	94.3	7.68	70.2	-	-	-	-
Histidine	%	-	-	2.06	96.2	3.72	73.6	-	-	-	-
Phenylalanine	%	-	-	3.85	93.9	4.37	71.5	-	-	-	-
Phe +Tyr	%	-	-	6.68	92.8	6.55	77.0	-	-	-	-

<sup>1</sup> Amino acid content<sup>2</sup> Coefficient of digestibility



Table 5 - Total and Digestible Amino Acid Content of Poultry and Swine Feedstuffs (as fed)

Nutrient		Casein	Cassava with Hulls Dried	Castor Oil Plant Meal	Citrus Pulp	Cocconut Meal					
Total Amino Acid											
		Value <sup>1</sup>	Value <sup>1</sup>	Value <sup>1</sup>	Value <sup>1</sup>	Value <sup>1</sup>					
Crude protein	%	84.21	2.47	39.20	6.37	21.85					
Lysine	%	6.94	0.09	0.78	0.17	0.58					
Methionine	%	2.60	0.03	0.61	0.07	0.33					
Met + Cys	%	2.97	0.07	1.07	0.16	0.62					
Tryptophan	%	1.08	0.02	0.58	0.05	0.18					
Threonine	%	3.79	0.07	1.13	0.18	0.67					
Arginine	%	3.07	0.15	3.21	0.24	2.56					
Gli + Ser	%	6.31	0.16	3.18	0.47	1.84					
Valine	%	5.66	0.11	1.78	0.25	1.12					
Isoleucine	%	4.61	0.09	1.75	0.19	0.77					
Leucine	%	7.47	0.12	2.68	0.32	1.37					
Histidine	%	2.43	0.08	56.00	0.17	0.44					
Phenylalanine	%	4.13	0.08	1.35	0.25	0.85					
Phe + Tyr	%	9.51	0.16	2.26	0.41	1.37					
True Digestible Amino acid - Poultry											
		Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>
Lysine	%	6.64	95.7	-	-	-	-	-	-	-	-
Methionine	%	2.50	96.3	-	-	-	-	-	-	-	-
Met + Cys	%	2.84	95.6	-	-	-	-	-	-	-	-
Tryptophan	%	1.05	96.9	-	-	-	-	-	-	-	-
Threonine	%	3.55	93.7	-	-	-	-	-	-	-	-
Arginine	%	3.05	99.3	-	-	-	-	-	-	-	-
Valine	%	5.55	98.1	-	-	-	-	-	-	-	-
Isoleucine	%	4.52	98.1	-	-	-	-	-	-	-	-
Leucine	%	7.44	99.6	-	-	-	-	-	-	-	-
Histidine	%	2.41	99.2	-	-	-	-	-	-	-	-
Phenylalanine	%	4.12	99.8	-	-	-	-	-	-	-	-
Phe +Tyr	%	9.49	99.8	-	-	-	-	-	-	-	-
True Digestible Amino Acid - Swine											
		Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>
Lysine	%	6.83	98.4	Value <sup>1</sup>	Coef. <sup>2</sup>	-	-	-	-	-	-
Methionine	%	2.57	98.9	-	-	-	-	-	-	-	-
Met + Cys	%	2.88	97.1	-	-	-	-	-	-	-	-
Tryptophan	%	1.06	98.3	-	-	-	-	-	-	-	-
Threonine	%	3.63	95.8	-	-	-	-	-	-	-	-
Arginine	%	-	-	-	-	-	-	-	-	-	-
Valine	%	5.43	95.9	-	-	-	-	-	-	-	-
Isoleucine	%	4.42	96.1	-	-	-	-	-	-	-	-
Leucine	%	-	-	-	-	-	-	-	-	-	-
Histidine	%	-	-	-	-	-	-	-	-	-	-
Phenylalanine	%	-	-	-	-	-	-	-	-	-	-
Phe +Tyr	%	-	-	-	-	-	-	-	-	-	-

<sup>1</sup> Amino acid content<sup>2</sup> Coefficient of digestibility

Table 5 - Total and Digestible Amino Acid Content of Poultry and Swine Feedstuffs (as fed)

Nutrient		Corn		Corn High Oil		Corn High Lysine		Corn Gluten Meal (21%)		Corn Gluten Meal (60%)	
Total Amino Acid											
		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>	
Crude protein	%	8.26		8.27		8.26		21.10		60.35	
Lysine	%	0.24		0.26		0.35		0.55		1.00	
Methionine	%	0.17		0.18		0.15		0.87		1.39	
Met + Cys	%	0.36		0.39		0.33		0.87		2.46	
Tryptophan	%	0.07		0.07		0.11		0.13		0.31	
Threonine	%	0.32		0.31		0.34		0.77		2.10	
Arginine	%	0.39		0.40		0.51		0.87		1.96	
Gli + Ser	%	0.73		0.79		0.82		1.88		4.88	
Valine	%	0.40		0.41		0.45		1.07		2.85	
Isoleucine	%	0.29		0.32		0.26		0.65		2.55	
Leucine	%	1.02		1.03		0.73		1.91		10.50	
Histidine	%	0.26		0.27		0.31		0.71		1.29	
Phenylalanine	%	0.41		0.42		0.34		0.76		3.96	
Phe + Tyr	%	0.70		-		0.57		1.22		7.27	
True Digestible Amino Acid - Poultry											
		Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>
Lysine	%	0.21	85.9	0.21	81.8	0.30	86.4	0.40	72.9	0.91	91.7
Methionine	%	0.16	92.3	0.16	91.4	0.13	89.9	0.29	85.2	1.34	96.5
Met + Cys	%	0.33	90.1	0.33	86.7	0.28	86.0	0.66	75.5	2.28	92.8
Tryptophan	%	0.06	90.5	0.06	87.4	0.10	90.9	0.10	77.5	0.28	91.0
Threonine	%	0.27	83.8	0.25	81.5	0.26	77.8	0.59	75.8	1.94	92.5
Arginine	%	0.36	92.0	0.37	93.3	0.47	92.2	0.78	89.4	1.89	96.7
Valine	%	0.35	88.2	0.34	82.6	0.38	85.4	0.89	83.4	2.68	93.9
Isoleucine	%	0.26	90.6	0.27	84.7	0.22	84.6	0.54	82.7	2.40	94.0
Leucine	%	0.97	95.4	0.95	92.1	0.66	90.9	1.72	90.0	10.23	97.4
Histidine	%	0.24	93.3	0.25	91.4	0.29	95.1	0.58	82.8	1.21	93.8
Phenylalanine	%	0.37	91.5	0.37	88.1	0.30	91.0	0.66	86.9	3.76	95.1
Phe +Tyr	%	0.63	90.7	-	-	0.51	90.2	1.05	85.7	7.09	97.4
True Digestible Amino Acid - Swine											
Lysine	%	0.19	79.8	0.20	76.9	0.27	78.4	0.36	65.7	0.86	85.9
Methionine	%	0.15	88.3	0.16	88.9	0.14	93.8	0.29	83.4	1.29	92.5
Met + Cys	%	0.32	87.0	0.32	84.2	0.30	91.4	0.64	73.5	2.25	91.4
Tryptophan	%	0.06	80.0	0.05	71.4	0.09	81.8	0.08	65.4	0.25	80.3
Threonine	%	0.26	81.0	0.26	82.8	0.27	80.0	0.55	70.6	1.90	90.6
Arginine	%	0.36	91.6	-	-	0.47	92.9	0.70	86.0	1.85	94.4
Valine	%	0.35	86.5	0.36	87.8	0.38	86.4	0.80	74.4	2.54	89.1
Isoleucine	%	0.25	87.1	0.27	87.1	0.22	84.6	0.51	78.1	2.26	88.6
Leucine	%	0.94	92.4	-	-	0.67	92.2	1.60	83.9	9.67	92.1
Histidine	%	0.23	89.5	-	-	0.28	90.0	0.51	72.9	1.18	91.8
Phenylalanine	%	0.37	90.8	-	-	0.31	91.7	0.65	84.9	3.63	91.8
Phe +Tyr	%	0.63	90.1	-	-	0.50	88.9	1.02	83.5	6.65	91.4

<sup>1</sup> Amino acid content<sup>2</sup> Coefficient of digestibility

Table 5 - Total and Digestible Amino Acid Content of Poultry and Swine Feedstuffs (as fed)

Nutrient		Corn Germ	Corn Pre-Cooked	Cottonseed Meal (30%)	Cottonseed Meal (39%)	Feather Meal (75%)					
Total Amino Acid											
		Value <sup>1</sup>	Value <sup>1</sup>	Value <sup>1</sup>	Value <sup>1</sup>	Value <sup>1</sup>					
Crude protein	%	10.45	7.61	29.80	39.45	74.70					
Lysine	%	0.46	0.26	1.24	1.64	2.29					
Methionine	%	0.19	0.18	0.46	0.59	0.64					
Met + Cys	%	0.42	0.36	0.95	1.28	3.74					
Tryptophan	%	0.11	0.06	0.51	0.51	0.53					
Threonine	%	0.39	0.30	0.97	1.36	3.73					
Arginine	%	0.66	0.33	3.47	4.46	5.07					
Gli + Ser	%	0.98	0.72	2.53	3.63	14.37					
Valine	%	0.51	0.40	1.33	1.87	5.70					
Isoleucine	%	0.34	0.32	0.93	1.37	3.68					
Leucine	%	0.91	1.01	1.76	2.39	6.56					
Histidine	%	0.31	0.27	0.84	1.15	1.06					
Phenylalanine	%	0.44	0.39	1.61	2.22	3.84					
Phe + Tyr	%	0.71	0.66	2.31	3.27	6.03					
True Digestible Amino Acid - Poultry											
		Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>
Lysine	%	0.39	85.1	0.22	85.3	0.91	73.3	1.21	73.6	1.65	72.1
Methionine	%	0.17	88.3	0.16	91.3	0.35	75.5	0.47	79.1	0.50	77.0
Met + Cys	%	0.35	84.3	0.32	88.9	0.64	67.7	0.95	74.0	2.19	58.6
Tryptophan	%	0.09	87.3	0.05	83.3	0.39	77.0	0.36	70.6	0.40	75.0
Threonine	%	0.30	76.5	0.25	83.1	0.67	69.5	0.99	73.3	2.55	68.3
Arginine	%	0.63	95.3	0.30	91.8	2.55	73.3	3.99	89.5	4.22	83.2
Valine	%	0.43	85.2	0.34	85.4	1.00	75.3	1.37	73.4	4.29	75.4
Isoleucine	%	0.29	85.8	0.31	97.1	0.84	90.4	0.96	70.2	2.95	80.1
Leucine	%	0.83	91.0	0.93	91.7	1.29	73.3	1.87	78.3	5.09	77.6
Histidine	%	0.28	91.0	0.25	93.9	0.61	72.5	0.91	78.5	0.76	71.3
Phenylalanine	%	0.39	89.5	0.36	91.9	1.26	77.9	1.91	86.1	3.12	81.2
Phe +Tyr	%	0.65	91.6	0.60	91.1	1.80	77.9	2.65	81.2	5.00	83.0
True Digestible Amino Acid - Swine											
Lysine	%	-	-	0.22	87.4	0.73	58.7	1.05	64.3	1.76	77.0
Methionine	%	-	-	0.16	90.9	0.32	69.7	0.45	75.3	0.48	75.1
Met + Cys	%	-	-	0.33	90.4	0.59	62.2	0.95	74.1	2.61	70.0
Tryptophan	%	-	-	0.05	86.6	0.36	70.2	0.35	68.3	0.38	72.0
Threonine	%	-	-	0.26	85.1	0.56	57.5	0.96	70.5	2.94	78.8
Arginine	%	-	-	0.31	93.1	3.07	88.4	3.99	89.5	4.47	88.1
Valine	%	-	-	0.35	88.7	0.87	65.7	1.39	74.4	4.45	78.1
Isoleucine	%	-	-	0.29	89.9	0.58	63.1	0.99	72.3	2.99	81.3
Leucine	%	-	-	0.91	90.2	1.17	66.6	1.78	74.6	5.18	79.0
Histidine	%	-	-	0.24	90.1	0.69	82.1	0.89	77.4	0.79	74.6
Phenylalanine	%	-	-	0.36	91.4	1.26	78.2	1.82	82.0	3.15	82.0
Phe +Tyr	%	-	-	0.58	87.7	1.86	80.2	2.65	81.0	4.94	82.0

<sup>1</sup> Amino acid content<sup>2</sup> Coefficient of digestibility

Table 5 - Total and Digestible Amino Acid Content of Poultry and Swine Feedstuffs (as fed)

Nutrient		Feather Meal (84%)		Feather & Poult. Byprod. Meal		Fish Meal (54%)		Fish Meal (61%)		Meat & Bone Meal (35%)	
Total Amino Acid											
		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>	
Crude protein	%	83.90		65.50		54.40		61.10		35.40	
Lysine	%	2.40		2.84		3.41		4.34		1.67	
Methionine	%	0.67		0.89		1.37		1.61		0.45	
Met + Cys	%	4.05		2.80		2.35		2.28		0.70	
Tryptophan	%	0.58		0.56		0.45		0.58		0.14	
Threonine	%	3.86		2.81		2.34		2.54		0.99	
Arginine	%	5.57		4.47		3.43		3.77		2.83	
Gli + Ser	%	15.16		10.10		7.68		7.79		8.03	
Valine	%	6.00		3.86		2.90		3.06		1.35	
Isoleucine	%	3.92		2.82		2.30		2.52		0.80	
Leucine	%	6.96		4.98		4.06		4.43		1.78	
Histidine	%	1.13		1.18		1.11		1.33		0.50	
Phenylalanine	%	4.06		2.93		2.32		2.39		1.06	
Phe + Tyr	%	6.52		5.24		3.87		4.41		1.65	
True Digestible Amino Acid - Poultry											
		Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>
Lysine	%	1.70	70.7	1.91	67.2	2.96	86.9	3.81	87.8	1.22	73.0
Methionine	%	0.51	76.7	0.77	87.5	1.22	89.1	1.44	89.3	0.27	59.1
Met + Cys	%	2.69	66.4	1.77	63.3	1.99	84.7	1.91	84.0	0.43	61.9
Tryptophan	%	0.43	74.8	0.46	82.0	0.39	87.4	0.50	86.6	0.09	63.2
Threonine	%	2.84	73.7	2.22	79.1	1.98	84.8	2.12	83.7	0.65	66.1
Arginine	%	4.52	81.0	3.71	83.1	3.06	89.3	3.33	88.4	2.20	77.9
Valine	%	4.77	79.5	3.05	78.8	2.48	85.7	2.64	86.3	0.91	67.2
Isoleucine	%	3.14	80.1	2.32	82.2	2.11	91.4	2.26	89.6	0.55	68.4
Leucine	%	5.33	76.6	3.89	78.2	3.53	87.0	3.84	86.6	1.26	70.7
Histidine	%	0.88	77.3	0.82	69.5	0.91	82.6	1.14	85.3	0.32	64.7
Phenylalanine	%	3.27	80.4	2.40	82.1	2.03	87.1	2.11	88.5	0.74	69.8
Phe +Tyr	%	5.35	81.9	4.23	80.7	3.21	83.1	3.88	88.0	1.24	75.1
True Digestible Amino acid - Swine											
Lysine	%	1.83	76.3	-	-	2.63	77.1	3.61	83.3	1.19	71.1
Methionine	%	0.53	80.2	-	-	1.02	74.2	1.31	81.3	0.37	80.8
Met + Cys	%	3.23	79.8	-	-	1.47	62.8	1.70	74.7	0.52	74.4
Tryptophan	%	0.39	67.3	-	-	0.33	73.7	0.46	80.1	0.11	76.0
Threonine	%	3.25	84.2	-	-	1.58	67.6	1.97	77.9	0.73	73.8
Arginine	%	4.84	86.8	-	-	2.85	83.0	3.13	83.0	2.37	83.8
Valine	%	5.05	84.1	-	-	2.03	70.2	2.44	79.6	1.00	74.0
Isoleucine	%	3.40	86.9	-	-	1.76	76.5	2.10	83.3	0.60	75.3
Leucine	%	5.89	84.6	-	-	2.97	73.1	3.55	80.1	1.40	78.9
Histidine	%	0.88	77.3	-	-	0.81	73.5	1.08	80.7	0.38	76.5
Phenylalanine	%	3.51	86.4	-	-	1.71	73.6	1.92	80.6	0.83	77.6
Phe +Tyr	%	5.52	84.6	-	-	3.06	79.0	3.55	80.6	1.14	69.4

<sup>1</sup> Amino acid content<sup>2</sup> Coefficient of digestibility

Table 5 - Total and Digestible Amino Acid Content of Poultry and Swine Feedstuffs (as fed)

Nutrient		Meat & Bone Meal (38%)		Meat & Bone Meal (41%)		Meat & Bone Meal (45%)		Meat & Bone Meal (51%)		Meat & Bone Meal (55%)			
Total Amino Acid													
		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>			
Crude protein	%	37.64		41.00		44.54		51.11		54.58			
Lysine	%	1.80		1.98		2.19		2.73		2.88			
Methionine	%	0.47		0.51		0.57		0.68		0.80			
Met + Cys	%	0.72		0.80		0.99		1.16		1.36			
Tryptophan	%	0.16		0.19		0.24		0.30		0.37			
Threonine	%	1.07		1.15		1.36		1.66		1.85			
Arginine	%	3.07		3.18		3.32		3.73		3.77			
Gli + Ser	%	8.30		8.49		8.79		9.18		9.62			
Valine	%	1.44		1.47		1.86		2.21		2.43			
Isoleucine	%	0.88		0.98		1.12		1.43		1.66			
Leucine	%	1.96		2.14		2.63		3.30		3.34			
Histidine	%	0.55		0.63		0.82		1.07		1.10			
Phenylalanine	%	1.18		1.24		1.55		1.79		1.91			
Phe + Tyr	%	1.78		1.88		2.38		2.83		3.00			
True Digestible Amino Acid - Poultry													
		Value <sup>1</sup>		Coef. <sup>2</sup>		Value <sup>1</sup>		Coef. <sup>2</sup>		Value <sup>1</sup>		Coef. <sup>2</sup>	
Lysine	%	1.54	85.3	1.67	84.2	1.80	82.2	2.25	82.5	2.33	81.0		
Methionine	%	0.37	77.7	0.38	74.3	0.45	78.7	0.55	80.2	0.67	83.7		
Met + Cys	%	0.54	74.5	0.59	73.7	0.77	77.3	0.87	74.5	0.99	73.0		
Tryptophan	%	0.14	87.1	0.16	82.5	0.18	75.5	0.25	83.3	0.28	75.0		
Threonine	%	0.84	78.9	0.88	76.6	1.08	78.9	1.29	77.8	1.47	79.4		
Arginine	%	2.63	85.5	2.61	82.0	2.65	79.7	3.23	86.5	3.17	84.0		
Valine	%	1.17	81.4	1.35	91.5	1.46	78.2	1.81	81.8	1.97	81.0		
Isoleucine	%	0.73	83.2	0.79	81.4	0.92	82.2	1.19	83.3	1.37	82.6		
Leucine	%	1.67	85.4	1.79	83.8	2.11	79.9	2.84	86.0	2.80	84.0		
Histidine	%	0.34	61.3	0.41	64.7	0.69	83.3	0.85	79.3	0.90	82.0		
Phenylalanine	%	0.98	82.9	1.04	83.5	1.21	78.0	1.54	86.0	1.60	84.0		
Phe +Tyr	%	1.37	77.4	1.53	81.4	1.90	79.8	2.43	85.8	-	-		
True Digestible Amino acid - Swine													
		Value <sup>1</sup>		Coef. <sup>2</sup>		Value <sup>1</sup>		Coef. <sup>2</sup>		Value <sup>1</sup>		Coef. <sup>2</sup>	
Lysine	%	1.54	85.3	1.67	84.2	1.80	82.2	2.25	82.5	2.30	79.9		
Methionine	%	0.37	77.7	0.38	74.3	0.45	78.7	0.55	80.2	0.66	82.3		
Met + Cys	%	0.54	74.5	0.59	73.7	0.77	77.3	0.87	74.5	1.08	79.0		
Tryptophan	%	0.14	87.1	0.16	82.5	0.18	75.5	0.25	83.3	0.29	78.9		
Threonine	%	0.84	78.9	0.88	76.6	1.08	78.9	1.29	77.8	1.44	77.8		
Arginine	%	2.63	85.5	2.61	82.0	2.65	79.7	3.23	86.5	3.24	86.0		
Valine	%	1.17	81.4	1.35	91.5	1.46	78.2	1.81	81.8	1.94	79.6		
Isoleucine	%	0.73	83.2	0.79	81.4	0.92	82.2	1.19	83.3	1.35	81.4		
Leucine	%	1.67	85.4	1.79	83.8	2.11	79.9	2.84	86.0	2.84	85.0		
Histidine	%	0.34	61.3	0.41	64.7	0.69	83.3	0.85	79.3	0.87	79.0		
Phenylalanine	%	0.98	82.9	1.04	83.5	1.21	78.0	1.54	86.0	1.62	85.0		
Phe +Tyr	%	0.98	82.9	1.04	83.5	1.21	78.0	1.54	86.0	2.52	84.0		

<sup>1</sup> Amino acid content<sup>2</sup> Coefficient of digestibility

Table 5 - Total and Digestible Amino Acid Content of Poultry and Swine Feedstuffs (as fed)

Nutrient		Meat & Bone Meal (60%)		Milk Skimmed Dried		Milk Whey Dried		Millet		Palm Ouricuri Meal	
Total Amino Acid											
		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>	
Crude protein	%	60.10		33.62		12.05		13.10		23.00	
Lysine	%	3.10		2.77		0.98		0.38		0.70	
Methionine	%	0.77		0.88		0.20		0.27		0.36	
Met + Cys	%	1.36		1.19		0.45		0.49		0.68	
Tryptophan	%	0.37		0.45		0.18		0.15		0.21	
Threonine	%	1.85		1.55		0.74		0.49		0.59	
Arginine	%	4.06		1.26		0.37		0.52		2.71	
Gli + Ser	%	10.35		2.59		1.09		1.01		1.68	
Valine	%	2.66		2.28		0.67		0.66		1.06	
Isoleucine	%	1.63		1.97		0.68		0.67		0.76	
Leucine	%	3.51		3.38		1.11		1.25		1.30	
Histidine	%	1.14		1.02		0.26		0.30		0.38	
Phenylalanine	%	2.00		1.70		0.41		0.60		0.92	
Phe + Tyr	%	3.27		3.11		0.62		0.87		1.39	
True Digestible Amino Acid - Poultry											
		Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>
Lysine	%	-	-	-	-	-	-	0.35	91.9	-	-
Methionine	%	-	-	-	-	-	-	0.25	92.4	-	-
Met + Cys	%	-	-	-	-	-	-	0.43	89.3	-	-
Tryptophan	%	-	-	-	-	-	-	0.14	92.9	-	-
Threonine	%	-	-	-	-	-	-	0.42	85.7	-	-
Arginine	%	-	-	-	-	-	-	0.50	96.7	-	-
Valine	%	-	-	-	-	-	-	0.59	89.3	-	-
Isoleucine	%	-	-	-	-	-	-	0.62	91.7	-	-
Leucine	%	-	-	-	-	-	-	1.18	94.7	-	-
Histidine	%	-	-	-	-	-	-	0.29	96.3	-	-
Phenylalanine	%	-	-	-	-	-	-	0.57	94.5	-	-
Phe +Tyr	%	-	-	-	-	-	-	0.81	92.8	-	-
True Digestible Amino Acid - Swine											
		-	-	2.65	95.6	0.90	92.0	Value <sup>1</sup>	Coef. <sup>2</sup>	-	-
Lysine	%	-	-	0.84	96.0	0.18	90.1	0.35	91.9	-	-
Methionine	%	-	-	1.11	92.8	0.41	90.5	0.25	92.4	-	-
Met + Cys	%	-	-	0.42	94.5	0.14	82.7	0.43	89.3	-	-
Tryptophan	%	-	-	1.41	91.2	0.64	86.3	0.14	92.9	-	-
Threonine	%	-	-	1.19	94.2	0.35	92.8	0.42	85.7	-	-
Arginine	%	-	-	2.07	91.2	0.58	87.2	0.50	96.7	-	-
Valine	%	-	-	1.77	90.1	0.62	89.9	0.59	89.3	-	-
Isoleucine	%	-	-	3.27	96.7	1.03	92.9	0.62	91.7	-	-
Leucine	%	-	-	0.97	94.7	0.24	91.9	1.18	94.7	-	-
Histidine	%	-	-	1.65	97.4	0.37	90.6	0.29	96.3	-	-
Phenylalanine	%	-	-	3.02	97.0	0.56	89.7	0.57	94.5	-	-
Phe +Tyr	%	-	-								

<sup>1</sup> Amino acid content<sup>2</sup> Coefficient of digestibility

Table 5 - Total and Digestible Amino Acid Content of Poultry and Swine Feedstuffs (as fed)

Nutrient		Passion Fruit Pulp Dried		Pasta- Spaghetti Residue		Peanut Meal		Poultry By-Product Meal		Poultry By-Product High Fat Meal	
Total Amino Acid											
		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>	
Crude protein	%	12.42		12.37		48.45		57.00		55.30	
Lysine	%	0.26		0.27		1.57		3.35		3.09	
Methionine	%	0.30		0.20		0.52		1.10		1.06	
Met + Cys	%	0.50		0.47		1.11		2.02		1.84	
Tryptophan	%	-		0.13		0.58		0.55		0.52	
Threonine	%	0.33		0.34		1.26		2.43		2.16	
Arginine	%	1.50		0.48		5.31		4.17		3.90	
Gli + Ser	%	1.10		1.00		4.95		8.44		7.75	
Valine	%	0.43		0.53		1.95		3.08		2.67	
Isoleucine	%	0.31		0.44		1.64		2.43		2.07	
Leucine	%	0.65		0.84		3.07		4.24		3.89	
Histidine	%	0.25		0.29		1.12		1.10		1.07	
Phenylalanine	%	0.85		0.57		2.37		2.49		2.24	
Phe + Tyr	%	1.05		0.85		4.18		4.12		3.71	
True digestible amino acid - Poultry											
		Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>
Lysine	%	0.18	71.9	0.23	84.8	-	-	2.67	79.8	-	-
Methionine	%	0.27	89.5	0.18	90.8	-	-	0.93	84.0	-	-
Met + Cys	%	0.28	56.5	0.43	92.0	-	-	1.57	77.5	-	-
Tryptophan	%	-	-	0.12	92.3	-	-	0.43	78.3	-	-
Threonine	%	0.20	59.2	0.27	79.6	-	-	1.92	79.2	-	-
Arginine	%	1.41	93.9	0.46	95.9	-	-	3.67	87.9	-	-
Valine	%	0.33	75.8	0.47	88.9	-	-	2.53	82.2	-	-
Isoleucine	%	0.24	78.2	0.40	91.5	-	-	2.05	84.3	-	-
Leucine	%	0.53	82.4	0.75	89.8	-	-	3.52	82.9	-	-
Histidine	%	0.20	80.0	0.25	87.1	-	-	0.89	81.0	-	-
Phenylalanine	%	0.78	91.6	0.54	95.1	-	-	2.13	85.3	-	-
Phe +Tyr	%	0.92	88.0	0.79	93.4	-	-	3.51	85.3	-	-
True Digestible Amino Acid - Swine											
Lysine	%	-	-	-	-	0.96	61.0	2.51	75.0	-	-
Methionine	%	-	-	-	-	0.38	74.0	0.87	78.8	-	-
Met + Cys	%	-	-	-	-	0.82	74.0	1.48	73.1	-	-
Tryptophan	%	-	-	-	-	0.42	72.0	0.43	78.0	-	-
Threonine	%	-	-	-	-	0.89	71.0	1.86	76.8	-	-
Arginine	%	-	-	-	-	4.83	91.0	3.56	85.4	-	-
Valine	%	-	-	-	-	1.58	81.0	2.21	71.9	-	-
Isoleucine	%	-	-	-	-	1.36	83.0	1.87	77.0	-	-
Leucine	%	-	-	-	-	2.64	86.0	3.24	76.4	-	-
Histidine	%	-	-	-	-	0.89	79.4	0.88	79.7	-	-
Phenylalanine	%	-	-	-	-	2.13	90.0	1.93	77.5	-	-
Phe +Tyr	%	-	-	-	-	3.76	90.0	3.17	76.9	-	-

<sup>1</sup> Amino acid content<sup>2</sup> Coefficient of digestibility

Table 5 - Total and Digestible Amino Acid Content of Poultry and Swine Feedstuffs (as fed)

Nutrient		Red Blood Cells		Rice Bran		Rice Bran Defatted		Sorghum High Tannin		Sorghum Low Tannin	
Total Amino Acid											
		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>	
Crude protein	%	84.10		13.24		15.50		8.94		9.23	
Lysine	%	8.73		0.63		0.69		0.20		0.20	
Methionine	%	1.24		0.26		0.31		0.15		0.15	
Met + Cys	%	1.82		0.52		0.60		0.32		0.32	
Tryptophan	%	1.41		0.16		0.19		0.09		0.09	
Threonine	%	4.34		0.49		0.58		0.31		0.31	
Arginine	%	3.48		1.00		1.13		0.35		0.35	
Gli + Ser	%	8.97		1.33		1.53		0.71		0.71	
Valine	%	8.30		0.71		0.82		0.47		0.47	
Isoleucine	%	0.49		0.47		0.54		0.37		0.37	
Leucine	%	12.60		0.96		1.10		1.20		1.20	
Histidine	%	5.91		0.34		0.40		0.21		0.21	
Phenylalanine	%	7.17		0.61		0.69		0.51		0.51	
Phe + Tyr	%	9.83		0.98		1.07		0.96		0.96	
True Digestible Amino Acid - Poultry											
		Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>
Lysine	%	8.04	92.2	0.48	76.8	0.53	76.8	0.14	72.7	0.17	84.8
Methionine	%	1.13	90.8	0.20	77.5	0.24	77.5	0.11	75.0	0.13	88.8
Met + Cys	%	1.60	88.0	0.38	72.1	0.43	72.1	0.22	69.7	0.27	86.2
Tryptophan	%	1.29	91.4	0.12	77.0	0.15	77.0	0.06	66.7	0.08	88.9
Threonine	%	3.92	90.4	0.35	70.9	0.41	70.9	0.21	69.7	0.26	85.4
Arginine	%	3.32	95.4	0.87	86.8	0.98	86.8	0.26	73.7	0.31	89.0
Valine	%	7.58	91.3	0.54	76.4	0.63	76.4	0.35	73.6	0.42	89.7
Isoleucine	%	0.41	82.7	0.35	75.1	0.41	75.1	0.27	74.4	0.34	91.0
Leucine	%	12.37	98.2	0.72	75.1	0.83	75.1	0.68	56.7	1.12	93.8
Histidine	%	5.73	96.9	0.29	83.9	0.34	83.9	0.12	59.1	0.18	87.7
Phenylalanine	%	7.07	98.6	0.46	75.2	0.52	75.2	0.39	77.1	0.48	95.0
Phe +Tyr	%	9.69	98.6	0.76	77.1	0.82	77.1	0.72	74.7	0.92	95.3
True Digestible Amino Acid - Swine											
Lysine	%	8.00	91.7	0.46	72.6	0.50	72.6	0.14	72.7	0.16	79.4
Methionine	%	1.14	91.3	0.19	72.3	0.23	72.3	0.12	81.3	0.13	86.4
Met + Cys	%	1.50	82.5	0.37	70.6	0.42	70.6	0.23	72.7	0.27	84.2
Tryptophan	%	1.24	87.7	0.11	70.0	0.13	70.0	0.07	77.8	0.08	81.9
Threonine	%	3.67	84.6	0.35	72.4	0.42	72.4	0.23	75.8	0.25	82.4
Arginine	%	3.18	91.4	0.86	85.9	0.97	85.9	0.24	68.4	0.31	86.6
Valine	%	7.29	87.8	0.52	73.5	0.60	73.5	0.37	79.2	0.40	85.2
Isoleucine	%	0.27	54.7	0.34	72.4	0.39	72.4	0.30	81.4	0.32	87.4
Leucine	%	11.87	94.2	0.71	73.9	0.81	73.9	1.02	85.1	1.05	88.1
Histidine	%	5.79	98.0	0.29	84.8	0.34	84.8	0.17	81.8	0.17	83.0
Phenylalanine	%	6.73	93.9	0.44	72.1	0.50	72.1	0.42	83.3	0.45	88.5
Phe +Tyr	%	9.06	92.2	0.74	75.2	0.80	75.2	0.80	83.5	0.85	88.3

<sup>1</sup> Amino acid content<sup>2</sup> Coefficient of digestibility



Table 5 - Total and Digestible Amino Acid Content of Poultry and Swine Feedstuffs (as fed)

Nutrient		Soybean Hulls	Soybean Protein Concentrate	Soybean Meal (45%)	Soybean Meal (48%)	Soybean Full-Fat Extruded					
Total Amino Acid											
		Value <sup>1</sup>	Value <sup>1</sup>	Value <sup>1</sup>	Value <sup>1</sup>	Value <sup>1</sup>					
Crude protein	%	13.50	62.92	45.32	47.90	37.00					
Lysine	%	0.89	4.07	2.77	2.92	2.23					
Methionine	%	0.17	0.93	0.64	0.66	0.53					
Met + Cys	%	0.39	1.90	1.27	1.37	1.08					
Tryptophan	%	0.14	0.87	0.62	0.64	0.47					
Threonine	%	0.51	2.60	1.78	1.86	1.47					
Arginine	%	0.81	5.32	3.33	3.50	2.71					
Gli + Ser	%	1.72	6.10	4.21	4.41	3.47					
Valine	%	0.65	3.18	2.16	2.30	1.78					
Isoleucine	%	0.56	3.02	2.10	2.20	1.70					
Leucine	%	0.93	5.10	3.52	3.63	2.81					
Histidine	%	0.37	1.73	1.17	1.29	0.99					
Phenylalanine	%	0.58	3.39	2.30	2.40	1.90					
Phe + Tyr	%	1.04	5.75	3.84	4.11	3.20					
True Digestible Amino Acid - Poultry											
		Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>
Lysine	%	0.59	66.2	3.75	92.2	2.55	92.2	2.70	92.6	2.02	90.4
Methionine	%	0.11	67.5	0.85	91.2	0.58	91.2	0.60	91.9	0.47	89.6
Met + Cys	%	0.21	52.1	1.67	87.6	1.11	87.5	1.21	88.4	0.93	86.0
Tryptophan	%	0.09	62.2	0.79	91.2	0.56	90.8	0.58	90.9	0.43	90.3
Threonine	%	0.25	49.5	2.29	88.2	1.57	88.6	1.66	89.3	1.29	87.4
Arginine	%	0.64	79.0	5.12	96.4	3.20	96.0	3.31	94.5	2.54	93.6
Valine	%	0.39	59.8	2.85	89.7	1.93	89.3	2.10	91.7	1.58	88.8
Isoleucine	%	0.36	64.5	2.76	91.4	1.92	91.3	2.02	92.1	1.53	89.8
Leucine	%	0.61	66.3	4.72	92.7	3.22	91.5	3.38	93.2	2.54	90.2
Histidine	%	0.18	50.0	1.62	93.4	1.11	94.2	1.18	91.7	0.90	91.0
Phenylalanine	%	0.39	66.7	3.13	92.2	2.13	92.7	2.24	93.3	1.71	89.7
Phe +Tyr	%	0.69	66.7	5.30	92.2	3.58	93.4	3.78	91.9	2.86	89.4
True Digestible Amino Acid - Swine											
Lysine	%	0.53	60.0	-	-	2.53	91.3	2.66	91.0	1.99	89.3
Methionine	%	0.12	71.0	-	-	0.59	92.3	0.60	91.8	0.47	88.2
Met + Cys	%	0.26	66.0	-	-	1.16	90.7	1.23	89.5	0.93	86.0
Tryptophan	%	0.09	63.0	-	-	0.55	89.0	0.57	89.6	0.40	85.0
Threonine	%	0.31	61.0	-	-	1.55	87.3	1.62	87.3	1.28	86.6
Arginine	%	0.68	84.0	-	-	3.19	95.7	3.31	94.6	2.52	93.0
Valine	%	0.40	61.0	-	-	1.92	88.9	2.04	89.0	1.55	86.7
Isoleucine	%	0.38	68.0	-	-	1.88	89.5	1.97	89.6	1.49	87.8
Leucine	%	0.65	70.0	-	-	3.19	90.5	3.26	90.0	2.49	88.6
Histidine	%	0.21	58.0	-	-	1.07	91.2	1.18	91.3	0.90	91.1
Phenylalanine	%	0.42	72.0	-	-	2.07	90.2	2.17	90.5	1.70	89.2
Phe +Tyr	%	0.72	69.0	-	-	3.42	89.1	3.75	91.2	2.87	89.8

<sup>1</sup> Amino acid content<sup>2</sup> Coefficient of digestibility

Table 5 - Total and Digestible Amino Acid Content of Poultry and Swine Feedstuffs (as fed)

Nutrient		Soybean Full-Fat Toasted		Soybean Full-Fat Micronized		Sweet Potato Dried		Swine By-Product Meal		Triticale	
Total Amino Acid											
		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>	
Crude protein	%	37.00		39.14		3.87		44.50		12.23	
Lysine	%	2.23		2.43		0.11		2.63		0.41	
Methionine	%	0.53		0.58		0.05		0.72		0.20	
Met + Cys	%	1.08		1.11		0.09		1.09		0.49	
Tryptophan	%	0.47		0.51		0.05		-		0.14	
Threonine	%	1.47		1.50		0.12		2.14		0.37	
Arginine	%	2.71		3.06		0.11		3.90		0.61	
Gli + Ser	%	3.47		3.67		0.56		8.52		1.13	
Valine	%	1.78		1.96		0.14		2.40		0.46	
Isoleucine	%	1.70		1.87		0.12		1.44		0.43	
Leucine	%	2.81		3.11		0.17		3.97		0.80	
Histidine	%	0.99		1.12		0.15		1.10		0.31	
Phenylalanine	%	1.90		2.09		0.14		1.88		0.56	
Phe + Tyr	%	3.20		3.42		0.21		2.89		0.86	
True Digestible Amino Acid - Poultry											
		Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>
Lysine	%	1.94	86.9	2.26	93.1	-	-	2.27	86.1	0.34	83.9
Methionine	%	0.46	86.0	0.53	92.2	-	-	0.63	87.2	0.18	90.0
Met + Cys	%	0.90	83.4	0.97	87.0	-	-	0.92	84.5	0.41	82.4
Tryptophan	%	0.40	85.5	0.47	92.2	-	-	-	-	0.12	89.3
Threonine	%	1.24	84.1	1.31	87.2	-	-	1.77	82.8	0.31	83.0
Arginine	%	2.48	91.4	2.86	93.3	-	-	3.48	89.1	0.56	92.6
Valine	%	1.51	84.4	1.74	88.9	-	-	2.13	88.9	0.40	85.8
Isoleucine	%	1.48	86.9	1.71	91.4	-	-	1.27	88.4	0.37	88.1
Leucine	%	2.44	86.9	2.87	92.2	-	-	3.54	89.1	0.70	87.8
Histidine	%	0.89	90.5	1.04	93.7	-	-	0.91	82.8	0.27	88.9
Phenylalanine	%	1.67	87.6	1.93	92.3	-	-	1.67	88.9	0.50	89.4
Phe +Tyr	%	2.81	87.9	3.27	95.5	-	-	2.55	88.1	0.73	84.9
True Digestible Amino Acid - Swine											
Lysine	%	1.81	81.1	2.26	92.8	0.06	58.3	2.00	75.9	0.33	81.3
Methionine	%	0.42	79.6	0.54	94.0	0.03	60.0	0.59	82.0	0.18	90.0
Met + Cys	%	0.85	78.1	1.00	89.6	0.05	54.5	0.87	80.0	0.44	88.7
Tryptophan	%	0.39	82.7	0.43	85.1	0.03	50.0	-	-	0.11	82.1
Threonine	%	1.15	78.1	1.28	85.1	0.05	45.5	1.77	82.4	0.29	80.0
Arginine	%	2.30	84.9	2.91	95.3	-	-	3.22	82.5	0.54	88.9
Valine	%	1.35	75.9	1.74	88.8	0.08	53.8	1.96	81.8	0.39	84.7
Isoleucine	%	1.30	76.7	1.71	91.4	0.06	53.8	1.19	82.4	0.37	87.9
Leucine	%	2.16	76.9	2.82	90.7	-	-	3.28	82.5	0.70	87.8
Histidine	%	0.81	82.3	1.04	93.3	-	-	0.58	52.2	0.26	85.2
Phenylalanine	%	1.49	78.5	1.91	91.4	-	-	1.53	81.6	0.50	89.4
Phe +Tyr	%	2.52	79.0	3.14	91.9	-	-	2.36	81.6	0.75	87.7

<sup>1</sup> Amino acid content<sup>2</sup> Coefficient of digestibility

Table 5 - Total and Digestible Amino Acid Content of Poultry and Swine Feedstuffs (as fed)

Nutrient		Wheat		Wheat Bran-Midds		Wheat Flour		Wheat Shorts		Wheat Germ	
Total Amino Acid											
		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>	
Crude protein	%	11.49		15.52		12.26		17.52		28.29	
Lysine	%	0.35		0.62		0.30		0.73		1.75	
Methionine	%	0.20		0.24		0.20		0.27		0.49	
Met + Cys	%	0.49		0.58		0.49		0.61		0.91	
Tryptophan	%	0.15		0.23		0.14		0.20		0.30	
Threonine	%	0.37		0.51		0.35		0.58		1.04	
Arginine	%	0.61		1.07		0.52		1.22		2.07	
Gli + Ser	%	1.17		1.38		1.04		0.94		2.39	
Valine	%	0.55		0.72		0.50		0.81		1.35	
Isoleucine	%	0.45		0.50		0.48		0.56		0.92	
Leucine	%	0.87		0.96		0.85		1.08		1.70	
Histidine	%	0.31		0.43		0.28		0.46		0.67	
Phenylalanine	%	0.60		0.60		0.60		0.69		0.99	
Phe + Tyr	%	0.91		0.99		0.88		1.09		1.67	
True Digestible Amino Acid - Poultry											
		Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>
Lysine	%	0.29	82.1	0.47	75.5	0.28	93.2	0.60	81.8	1.64	93.8
Methionine	%	0.18	89.4	0.18	73.9	0.19	95.2	0.22	81.6	0.46	94.4
Met + Cys	%	0.43	87.8	0.43	74.6	0.46	93.6	0.50	81.4	0.83	91.6
Tryptophan	%	0.12	85.2	0.18	80.0	0.13	92.9	0.17	85.0	0.26	86.7
Threonine	%	0.30	81.4	0.37	72.1	0.31	87.1	0.46	79.3	0.91	88.3
Arginine	%	0.55	90.4	0.96	90.0	0.50	96.4	1.12	92.3	1.96	94.6
Valine	%	0.47	85.8	0.52	72.4	0.47	92.8	0.66	82.0	1.21	89.6
Isoleucine	%	0.40	88.6	0.38	74.9	0.46	95.0	0.46	83.5	0.84	91.5
Leucine	%	0.78	89.4	0.74	76.8	0.80	94.3	0.92	85.2	1.56	91.5
Histidine	%	0.27	87.4	0.34	80.3	0.27	94.2	0.40	86.8	0.63	93.7
Phenylalanine	%	0.54	89.9	0.48	78.6	0.56	93.3	0.61	87.8	0.90	91.1
Phe +Tyr	%	0.81	89.1	0.79	79.2	0.81	92.4	0.94	87.1	1.53	91.7
True Digestible Amino Acid - Swine											
Lysine	%	0.29	82.7	0.46	74.6	-	-	0.54	73.6	1.52	86.9
Methionine	%	0.18	89.5	0.19	81.8	-	-	0.22	80.0	0.44	89.8
Met + Cys	%	0.44	89.4	0.46	79.2	-	-	0.45	74.1	0.75	82.6
Tryptophan	%	0.13	86.5	0.17	75.0	-	-	0.15	75.0	0.22	73.3
Threonine	%	0.31	83.6	0.37	71.4	-	-	0.41	71.7	0.80	77.5
Arginine	%	0.53	87.6	0.95	88.7	-	-	1.04	85.7	1.93	93.1
Valine	%	0.47	86.0	0.55	76.1	-	-	0.62	77.2	1.11	82.4
Isoleucine	%	0.40	89.0	0.39	76.8	-	-	0.43	77.8	0.75	82.4
Leucine	%	0.78	89.6	0.76	78.6	-	-	0.86	80.0	1.43	84.0
Histidine	%	0.27	89.4	0.36	84.1	-	-	0.37	81.4	0.62	92.2
Phenylalanine	%	0.55	91.8	0.49	81.8	-	-	0.56	81.4	0.85	86.0
Phe +Tyr	%	0.82	90.8	0.78	79.0	-	-	0.86	79.6	1.46	87.6

<sup>1</sup> Amino acid content<sup>2</sup> Coefficient of digestibility

Table 5 - Total and Digestible Amino Acid Content of Poultry and Swine Feedstuffs (as fed)

Nutrient		Wheat Screenings		Triticale		Yeast Alcohol Distillery		Yeast Brewery
Total Amino Acid								
		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>		Value <sup>1</sup>
Crude protein	%	13.61		12.23		36.75		42.60
Lysine	%	0.46		0.41		3.06		3.65
Methionine	%	0.21		0.20		0.62		0.70
Met + Cys	%	0.50		0.49		0.91		1.06
Tryptophan	%	0.42		0.14		0.50		0.51
Threonine	%	0.42		0.37		2.20		2.35
Arginine	%	0.67		0.61		1.78		2.20
Gli + Ser	%	1.22		1.13		3.87		4.29
Valine	%	0.60		0.46		2.29		2.38
Isoleucine	%	0.48		0.43		1.96		2.51
Leucine	%	0.89		0.80		2.86		3.23
Histidine	%	0.32		0.31		0.85		0.98
Phenylalanine	%	0.55		0.56		1.68		1.88
Phe + Tyr	%	0.89		0.86		2.47		3.22
True Digestible Amino Acid - Poultry								
		Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>	Coef. <sup>2</sup>	Value <sup>1</sup>
Lysine	%	0.38	83.5	0.34	83.9	2.13	69.6	2.54
Methionine	%	0.18	86.9	0.18	90.0	0.35	56.4	0.40
Met + Cys	%	0.45	89.8	0.41	82.4	0.45	49.0	0.52
Tryptophan	%	0.38	90.5	0.12	89.3	0.24	48.4	0.25
Threonine	%	0.38	90.4	0.31	83.0	1.06	48.3	1.13
Arginine	%	0.66	98.5	0.56	92.6	1.28	71.8	1.58
Valine	%	0.52	87.3	0.40	85.8	0.60	26.2	0.79
Isoleucine	%	0.43	90.4	0.37	88.1	0.65	33.3	0.66
Leucine	%	0.81	91.2	0.70	87.8	1.08	37.7	1.22
Histidine	%	0.26	80.6	0.27	88.9	0.47	54.5	0.53
Phenylalanine	%	0.52	94.5	0.50	89.4	0.72	42.9	0.80
Phe + Tyr	%	0.84	94.6	0.73	84.9	1.06	42.9	1.38
True Digestible Amino Acid - Swine								
Lysine	%	-	-	0.33	81.3	2.55	83.1	3.03
Methionine	%	-	-	0.18	90.0	0.48	77.1	0.54
Met + Cys	%	-	-	0.44	88.7	0.66	72.5	0.77
Tryptophan	%	-	-	0.11	82.1	0.39	78.4	0.40
Threonine	%	-	-	0.29	80.0	1.55	70.6	1.66
Arginine	%	-	-	0.54	88.9	1.50	84.4	1.85
Valine	%	-	-	0.39	84.7	1.69	73.7	1.73
Isoleucine	%	-	-	0.37	87.9	1.48	75.4	1.87
Leucine	%	-	-	0.70	87.8	2.21	77.4	2.45
Histidine	%	-	-	0.26	85.2	0.68	79.4	0.79
Phenylalanine	%	-	-	0.50	89.4	1.31	77.8	1.39
Phe + Tyr	%	-	-	0.75	87.7	2.06	83.4	2.52

<sup>1</sup> Amino acid content<sup>2</sup> Coefficient of digestibility

Table 6 - Composition, Digestibility and Energy Values of Synthetic Amino Acids for Poultry (dry matter basis)

Amino acid	Nitrogen (%)	Protein (N x 6,25) (%)	True Digestibility <sup>1</sup> (%)	Gross Energy (kcal/kg)	True Dig. and Met. Energy	
					TDE-(kcal/kg)-TMEn <sup>2</sup>	
Alanine	16.39	102.45	99.7	4,389	4,376	3,029
Arginine	29.90	186.60	100	4,492	4,492	2,863
Aspartic acid	10.30	64.36	99.7	2,854	2,854	1,998
Cystine	11.90	74.40	97.2	4,325	4,204	3,226
Phenylalanine	8.21	51.32	98.1	6,932	6,800	6,125
Glycine	19.00	118.75	97.0	3,163	3,068	1,506
Glutamic acid	9.09	56.80	99.4	3,686	3,664	2,917
Histidine	23.83	148.90	99.0	4,036	3,996	2,037
Isoleucine	11.01	68.78	100	6,605	6,605	5,700
Leucine	10.98	68.63	99.5	6,714	6,680	5,777
Lysine - HCL	13.73	85.81	99.8	4,901	4,891	3,762
Methionine	9.50	59.38	99.2	5,684	5,639	4,858
Proline	11.28	70.51	99.1	5,065	5,019	4,092
Tyrosine	7.80	48.75	99.6	3,860	3,845	2,994
Threonine	12.50	78.09	98.1	4,173	4,094	3,067
Tryptophan	13.71	85.64	99.3	6,506	6,461	5,334
Valine	12.59	78.68	100	6,026	6,026	4,991

<sup>1</sup> Determined with cecectomized cockerels and broiler chicks (ileal digestibility).<sup>2</sup> Considering nitrogen conversion to uric acid, except for arginine to urea.

Table 7 - Composition, Digestibility and Energy Values of Synthetic Amino Acids for Swine (dry matter basis)

Amino acid	Nitrogen (%)	Protein (N x 6,25) (%)	True Digestibility <sup>1</sup> (%)	Gross Energy (kcal/kg)	True Dig. and Met. Energy	
					TDE-(kcal/kg)-TME <sup>2</sup>	
Alanine	16.39	102.45	92.0	4,389	4,038	3,725
Arginine	29.90	186.60	95.5	4,492	4,290	3,720
Aspartic acid	10.30	64.36	93.5	2,854	2,669	2,473
Cystine	11.90	74.40	92.4	4,325	3,996	3,769
Phenylalanine	8.21	51.32	95.2	6,932	6,599	6,442
Glycine	19.00	118.75	97.0	3,163	3,068	2,706
Glutamic acid	9.09	56.80	99.2	3,686	3,657	3,484
Histidine	23.83	148.90	100.0	4,036	4,036	3,581
Isoleucine	11.01	68.78	97.1	6,605	6,414	6,204
Leucine	10.98	68.63	95.4	6,714	6,405	6,196
Lysine - HCL	13.73	85.81	98.1	4,901	4,808	4,599
Methionine	9.50	59.38	99.5	5,684	5,656	5,475
Proline	11.28	70.51	99.0	5,065	5,014	4,799
Tyrosine	7.80	48.75	98.0	5,990	5,870	5,721
Threonine	12.50	78.09	96.8	4,173	4,040	3,802
Tryptophan	13.71	85.64	99.0	6,506	6,441	6,180
Valine	12.59	78.68	95.5	6,026	5,755	5,069

<sup>1</sup> Determined with cannulated pig at the terminal ileum.<sup>2</sup> Considering the conversion of 35% of nitrogen to urea.

Table 8 - Mineral Sources for Poultry and Swine (as fed)

Phosphorus Sources	Ca	Phosphorus (P) %					Fluorine
	%	Total	Coeff. <sup>1</sup> Avail.	Avail. <sup>1</sup> Poultry	Coeff. Dig <sup>2</sup> .	Dig <sup>2</sup> Swine	%
Phosphoric Acid	-	21.5	120	25.8	90.0	19.4	0.16
Bone Meal Steamed	25.0	11.4	100	11.4	63.1	7.2	-
Bone Meal ash	33.8	16.2	92	14.9	--	-	-
Phosphate Dicalcium	24.5	18.5	100	18.5	76.1	14.1	0.14
Phosph. Monodicalcium	20.0	18.9	105	19.8	82.7	15.6	0.19
Phosph. Monocalcium	18.6	21.0	101	21.2	78.2	16.4	0.25
Phosp. Monoammonium	-	24.0	108	25.9	-	-	0.22
Phosph. Diammonium	-	23.1	125	28.9	-	-	0.10
Phosphate Tricalcium	36.2	17.6	100	17.6	-	-	-
Rock Phosph. Araxá	26.0	12.1	51	6.2	-	-	1.59
Rock Phosph. Catalão	32.3	15.1	52	7.9	63.3	9.6	2.17
Rock Phos. Jacupiranga	34.8	13.2	31	4.1	-	-	1.65
Rock Phos. Patos Minas	20.8	10.6	58	6.1	-	-	1.50
Rock Phosphate Tapira	33.6	15.0	52	7.8	-	-	1.10
Phos Semidefluorinated	30.3	16.7	61	10.2	-	-	0.88
Phosphat. Super Simple	21.5	8.6	-	-	-	-	1.31
Phosphate Super Triple	17.9	20.4	100	20.4	76.9	15.7	0.74
<u>Calcium and Magnesium Sources</u>			<u>Calcium</u> %	<u>Magnesium</u> %			
Limestone			38.4	0.2			
Dolomitic Limestone			18.6	10.0			
Oyster Shell			36.4	-			
<u>Sodium Sources</u>		<u>Sodium</u> %	<u>Chloride</u> %				
Salt		39.7	59.6				
Sodium Bicarbonate		27.0	0.0				

<sup>1</sup> P Coefficient (Coef) and availability (Avail) as compared to dicalcium phosphate determined with poultry.

<sup>2</sup> P Coefficient (Coef.) and true digestibility (Dig.) determined with swine.

Table 9 - Mineral Content of Brazilian Phosphates (as fed)

Phosphate	Mg <sup>1</sup>	Mn <sup>1</sup>	Zn <sup>1</sup>	Fe <sup>1</sup>	Cu <sup>1</sup>	Cr <sup>1</sup>	Pb <sup>1</sup>	Ni <sup>1</sup>	Cd <sup>1</sup>	Va <sup>1</sup>
	%	mg / kg-----								
Phosphoric Acid P A	0.37	0.7	0.6	31.3	1.8	3.7	12.6	0.5	2.0	-
Phosphoric Acid	0.56	29.7	7.3	39.3	4.9	8.1	13.6	5.1	2.1	-
Phosphate Dicalcium	0.91	284.2	40.3	4023	11.7	17.4	24.0	19.7	3.6	74.0
Phosph. Monodicalc.	0.81	36.3	4.6	1432	7.8	5.9	18.5	9.6	2.0	-
Ph. Monoammonium	-	371.0	130.0	9000	79.0	50.0	10.0	27.0	4.6	54.0
Rock Ph. Araxá	0.54	52.5	208.8	6464	11.1	13.5	39.1	40.6	3.7	-
Rock Ph. Catalão	0.81	405.0	36.7	8486	14.9	9.1	37.1	37.2	2.9	-
Rock Ph. Jacupiranga	-	321.0	11.0	6000	27.0	3.0	12.0	10.0	1.0	17.0
Rock Ph. Tapira	0.50	234	127.0	7520	9.8	5.4	28.7	16.3	3.5	70.0
Ph. Semidefluorinated	0.81	19.0	3.8	913	139.6	5.9	48.5	22.2	3.3	-
Ph. Super Simple	0.46	36.1	142.4	7010	13.9	17.5	18.9	28.6	3.0	-
Ph. Super Triple	0.71	36.2	154.6	3298	38.0	93.4	19.0	25.2	4.9	41.0

<sup>1</sup> Mg = Magnesium, Mn = Manganese, Zn = Zinc, Fe = Iron, Cu = Copper, Cr = Chromium, Pb = Lead. Ni = Nickel, Cd = Cadmium, Va = Vanadium.



Table 10 - Mineral Content of Feedstuffs (as fed)

Alimento	Magnesium %	Manganese	Iron	Copper	Zinc	Selenium
		mg / kg				
Bakery-Cracker Residue	0.04	13.4	125.1	3.2	61.5	-
Blood Meal	0.10	7.3	1664	13.8	36.1	0.58
Blood Plasma	0.02	-	105.9	45.9	89.2	0.42
Cassava with Hulls Dried	0.09	23.9	92.6	4.5	11.1	0.15
Castor Oil Plant. Meal	0.35	23.7	1.0	3.9	11.3	-
Coconut Meal	0.26	68.2	423	25.6	62.3	-
Corn	0.09	5.3	43.1	2.9	19.4	0.07
Corn Germ	0.31	19.6	116.4	10.0	45.9	0.10
Corn Gluten Meal (21%)	0.30	19.2	133.5	16.9	72.9	0.21
Corn Gluten Meal (60%)	0.06	3.1	112.9	19.1	25.3	0.20
Corn High Lysine	0.05	10.3	53.4	2.6	17.6	0.05
Corn High Oil	0.10	4.3	93.0	3.0	21.5	0.19
Corn Pre-Cooked	0.04	11.4	43.9	2.7	26.5	0.16
Cottonseed Meal (30%)	0.36	9.7	53.9	6.7	23.9	0.31
Cottonseed Meal (39%)	0.47	14.3	157.9	10.5	56.7	0.58
Feather & Poult. B-P Meal	0.13	6.8	221.1	9.5	95.2	0.61
Feather Meal (75%)	0.04	3.3	461.6	20.9	76.5	0.29
Fish Meal (54%)	0.16	41.4	444.1	12.0	84.3	0.79
Meat & Bone Meal (35%)	0.22	11.7	816.4	36.3	66.9	0.42
Meat & Bone Meal (41%)	0.22	1.5	323.9	48.0	69.3	0.36
Meat & Bone Meal (45%)	0.29	12.9	449.7	14.0	80.6	0.30
Meat & Bone Meal (51%)	0.44	20.0	247.7	8.5	80.8	0.37

Table 10 - Mineral Content of Feedstuffs (as fed)

Feedstuffs	Magnesium	Manganese	Iron	Copper	Zinc	Selenium
	%	-----mg / kg-----				
Milk Whey Dried	0.11	3.0	12.3	16.5	114.6	0.21
Millet	0.15	17.79	96.8	17.6	29.03	0.061
Palm Meal	0.38	118.1	350	16.8	38.2	-
Palm Ouricuri Meal	0.25	39.3	310.0	15.6	68.7	-
Pasta-Spaghetti Residue	0.05	9.4	195.8	3.4	35.6	-
Peanut Meal	0.31	37	195	17.5	48.3	0.25
Poultry By-Product Meal	0.11	2.1	175.5	19.3	80.4	0.52
Red Blood Cells	0.01	-	2021	13.8	130.3	0.24
Rice Bran	0.81	194.5	115.4	28.2	49.8	0.35
Rice Bran Defatted	0.75	170.3	170.1	14.7	47.7	-
Rice Broken	0.08	16.6	15.6	2.3	10.3	0.31
Sorghum Low Tannin	0.11	10.9	59.7	7.6	18.6	0.25
Soyb. Full-Fat Extr./Toasted	0.32	24.8	179.1	14.7	41.6	0.21
Soyb. Full-Fat Micronized	0.20	19.2	56.2	13.7	36.2	0.20
Soybean Hulls	0.17	19.0	534.0	76.2	35.7	0.22
Soybean Meal (45%)	0.21	31.9	157.1	20.2	46.2	0.44
Soybean Meal (48%)	0.23	31.7	168.0	--	44.8	0.34
Soybean Protein Concent.	0.29	38.3	92.3	32.6	24.0	--
Sugarcane Molass. Dried	0.19	76.4	238.5	19.4	21	-
Sugarcane Molasses	0.35	43.9	200	55	33.1	-
Swine By-Product Meal	0.15	23.9	655.0	16.7	115.0	-
Triticale	0.10	38.3	44.9	6.4	32.7	0.31
Wheat	0.12	29.7	68.4	5.6	49.8	0.35
Wheat Bran-Midds	0.43	102.7	181.2	16.0	134.5	0.31
Wheat Flour	0.03	6.8	29.3	3.01	22.0	-
Wheat Germ	0.25	134.5	110.3	4.8	197.4	-
Wheat Screenings	0.17	44.6	156.4	21.8	64.1	-
Wheat Shorts	0.31	103.5	162.8	14.1	141.0	-
Yeast Alcohol Distillery	0.09	14.0	191.3	30.0	107.9	0.55

Table 11 - Sources of Trace Minerals Used to Supplement Poultry and Swine Diets

Sources of Cobalt	Co (%)
Cobalt Carbonate ( $\text{CoCO}_3$ )	45.0
Cobalt Sulfate ( $\text{CoSO}_4 \cdot \text{H}_2\text{O}$ )	33.0
Cobalt Sulfate ( $\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$ )	21.0
Sources of Copper	Cu (%)
Copper Carbonate ( $\text{CuCO}_3 \cdot \text{Cu(OH)}_2$ )	53.0
Copper Oxide ( $\text{CuO}$ )	75.0
Copper Sulfate ( $\text{CuSO}_4 \cdot \text{H}_2\text{O}$ )	34.5
Copper Sulfate ( $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ )	25.0
Sources of Iron	Fe (%)
Iron Carbonate ( $\text{FeCO}_3$ )	43.0
Ferrous Sulfate ( $\text{FeSO}_4 \cdot \text{H}_2\text{O}$ )	30.0
Ferrous Sulfate ( $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ )	20.0
Sources of Iodine	I (%)
Calcium Iodate ( $\text{Ca(IO}_3)_2$ )	62.0
Copper Iodide ( $\text{CuI}_2$ )	66.0
Potassium Iodate ( $\text{KIO}_3$ )	59.0
Potassium Iodide ( $\text{KI}$ )	76.0
Sources of Manganese	Mn (%)
Manganese Carbonate ( $\text{MnCO}_3$ )	47.0
Manganous Oxide ( $\text{MnO}$ )	52 - 62
Manganese Sulfate ( $\text{MnSO}_4 \cdot \text{H}_2\text{O}$ )	31.0
Manganese Sulfate ( $\text{MnSO}_4 \cdot 5\text{H}_2\text{O}$ )	22.7
Sources of Selenium	Se (%)
Sodium Selenide ( $\text{Na}_2\text{SeO}_4$ )	42.0
Sodium Selenite ( $\text{Na}_2\text{SeO}_3$ )	45.0
Sources of Zinc	Zn (%)
Zinc Carbonate ( $\text{ZnCO}_3$ )	52.0
Zinc Oxide ( $\text{ZnO}$ )	73.0
Zinc Sulfate ( $\text{ZnSO}_4 \cdot \text{H}_2\text{O}$ )	35.0
Zinc Sulfate ( $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ )	22.0

Table 12 - Vitamin and Mineral Supplementation Levels in Poultry Diets (amount / kg diet)

Nutrient		Broilers and Replacement Pullets		Broilers	Layers	Breeders
		Starter	Grower	Withdrawal		
Vitamin A	UI	10,000	8,000	4,000	7,000	9,000
Vitamin D <sub>3</sub>	UI	2,000	1,600	800	1,600	2,500
Vitamin E	UI	35	28	14	8	40
Vitamin K <sub>3</sub>	Mg	1.7	1.4	0.7	1.0	2
Vitamin B <sub>1</sub>	Mg	1.5	1.2	0.6	1.0	1.8
Vitamin B <sub>2</sub>	Mg	5	4	2	4.0	7.0
Nicotinic Acid	Mg	35	28	14	20	30
Pantothenic Ac.	Mg	12	9.6	4.8	7	13
Vitamin B <sub>6</sub>	Mg	2.4	1.9	0.96	1.0	2
Vitamin B <sub>12</sub>	Mg	0.012	0.010	0.005	0.010	0.020
Folic Acid	Mg	0.700	0.560	0.280	0.300	0.900
Biotin	Mg	0.070	0.056	0.028	0.020	0.100
Choline	Mg	300	240	120	200	300
Copper	Mg	11	10	7.5	10	11
Iron	Mg	55	50	37.5	50	55
Iodine	Mg	0.88	0.8	0.6	0.8	0.88
Manganese	Mg	71.5	65	48.8	65	71.5
Selenium	Mg	0.33	0.30	0.23	0.30	0.33
Zinc	Mg	66	60	45	60	66

Table 13 - Mineral Supplement for Poultry Diets<sup>1,2</sup>

Element	Amount g/kg	Mineral Source	Amount g/kg
Copper	10.0	Copper Sulfate (CuSO <sub>4</sub> 5H <sub>2</sub> O)	40.00
Iron	50.0	Ferrous Sulfate (FeSO <sub>4</sub> H <sub>2</sub> O)	166.67
Iodine	0.8	Potassium Iodate (KIO <sub>3</sub> )	1.36
Manganese	65.0	Manganese Sulfate (MnSO <sub>4</sub> H <sub>2</sub> O)	209.68
Selenium	0.3	Sodium Selenite (Na <sub>2</sub> SeO <sub>3</sub> )	0.67
Zinc	60.00	Zinc Oxide (ZnO)	82.19
Excipient			499.43
Total			1,000.00

<sup>1</sup> Calculations made using data from Tables 11 and 12.<sup>2</sup> Recommended addition per tonne of diet: Broilers, Pre-starter and Starter, 1.1 kg; Broilers Grower, 1.0 kg; Broilers Withdrawal, 0.75 kg; Replacement Pullets Starter, 1.1 kg; Replacement Pullets Grower, 1.0 kg; Layers, 1.0 kg; Breeders, 1.1 kg.

Table 14 - Vitamin and Mineral Supplementation Levels in Swine Diets (amount / kg diet)

Nutrient		Pre-starter	Starter	Grower	Finisher	Reproduction
Vitamin A	UI	7,700	7,000	5,600	3,500	8,000
Vitamin D <sub>3</sub>	UI	1,650	1,500	1,200	750	1,200
Vitamin E	UI	44	40	32	20	45
Vitamin K <sub>3</sub>	mg	3.3	3	2.4	1.5	2
Vitamin B <sub>1</sub>	mg	1.1	1	0.8	0.5	1
Vitamin B <sub>2</sub>	mg	3.85	3.5	2.0	1.75	4
Nicotinic Acid	mg	33	30	24	15	22
Pantothenic Ac.	mg	16.5	15	12	7.5	16
Vitamin B <sub>6</sub>	mg	2.2	2	1.6	1	1.2
Vitamin B <sub>12</sub>	mg	0.022	0.020	0.016	0.010	0.020
Folic Acid	mg	0.330	0.300	0.240	0.150	1.000
Biotin	mg	0.110	0.100	0.080	0.050	0.250
Choline	mg	220	200	160	100	500
Copper	mg	13.2	12	9.6	6	12
Iron	mg	88	80	64	40	80
Iodine	mg	1.1	1.0	0.8	0.5	1.0
Manganese	mg	44	40	32	20	40
Selenium	mg	0.40	0.36	0.29	0.18	0.36
Zinc	mg	110	100	80	50	100

Table 15 - Mineral Supplement for Swine Diets<sup>1,2</sup>

Element	Amount g/kg	Mineral Source	Amount g/kg
Copper	12	Copper Sulfate (CuSO <sub>4</sub> 5H <sub>2</sub> O)	48.00
Iron	80	Ferrous Sulfate (FeSO <sub>4</sub> H <sub>2</sub> O)	266.67
Iodine	1	Potassium Iodate (KIO <sub>3</sub> )	1.69
Manganese	40	Manganese Sulfate (MnSO <sub>4</sub> H <sub>2</sub> O)	129.03
Selenium	0.36	Sodium Selenite (Na <sub>2</sub> SeO <sub>3</sub> )	0.80
Zinc	100	Zinc Oxide (ZnO)	136.99
		Excipient	416.82
Total			1,000.00

<sup>1</sup> Calculations made using data from Tables 11 and 14.

<sup>2</sup> Recommended addition per tonne of diet in each phase: Pre-starter, 1.1 kg; Starter, 1 kg.; Grower, 0.8 kg; Finisher, 0.5 kg; Reproduction, 1 kg.

Table 16 - Practical (Pr) and Maximum (Max) Inclusion Levels of Feedstuffs in Broiler and Layer Diets (percentage in the diet)

Feedstuffs	Broilers				Layers	
	Starter		Grower		Laying	
	Pr	Max	Pr	Max	Pr	Max
Bakery-Cracker Residue	5	10	8	15	8	15
Blood Meal	1	2	2	3	1	2
Canola Meal	1	3	2	5	2	4
Carob Meal	3	5	4	8	5	10
Cassava with Hulls Dried	5	20	10	20	10	20
Coconut Meal	3	6	4	8	5	8
Corn	65	65	65	65	65	65
Corn Germ	5	15	10	20	10	20
Corn Gluten Meal (22%)	3	8	4	8	4	12
Corn Gluten Meal (60%)	4	8	4	8	4	10
Corn High Lysine	65	65	65	65	65	65
Corn High Oil	60	65	55	65	60	65
Cottonseed Meal (30%)	2	4	3	5	3	5
Cottonseed Meal (39%)	3	7	5	8	5	8
Fat Poultry, Coconut, Lard	3	6	3	7	3	7
Fat Tallow	2	4	3	6	3	6
Feather & Poult B-PMeal	2	4	2	4	2	4
Feather Meal	1	2	2	4	2	4
Fish Meal	3	7	2	5	2	5
Meat & Bone Meal (41)	4	7	4	8	4	8
Meat & Bone Meal (51%)	5	8	5	10	5	10



Table 16 - Practical (Pr) and Maximum (Max) Inclusion Levels of Feedstuffs in Broiler and Layer Diets (percentage in the diet)

Feedstuffs	Broilers				Layers	
	Starter		Grower		Production	
	Pr	Max	Pr	Max	Pr	Max
Millet	15	40	20	45	20	45
Oil Vegetable / Plant	3	6	3	7	3	7
Pasta- Spaghetti Residue	10	15	12	20	12	20
Peanut Meal	3	7	5	10	5	10
Poultry By-Product Meal	3	7	3	8	3	8
Rice Bran	3	8	6	12	6	12
Rice Bran Defatted	2	6	5	8	5	10
Rice Broken	30	65	30	65	30	65
Sorghum High Tannin	15	30	20	30	20	30
Sorghum Low Tannin	30	65	30	65	30	65
Soybean Full-Fat Extr.	8	15	10	20	10	20
Soybean Full-Fat Micron	8	15	10	20	10	20
Soybean Full-Fat Toast.	5	10	8	20	10	20
Soybean Meal (45%)	35	35	35	35	30	30
Soybean Meal (48%)	35	35	35	35	30	30
Sugarcane	-	5	-	10	-	15
Sugarcan. Molasses Dried	1	2	1	3	1	3
Sugarcan. Molasses	1	1	1	3	1	3
Swine By-Product Meal	4	7	4	8	4	8
Triticale	10	20	15	25	15	30
Wheat	12	20	20	30	20	30
Wheat Bran-Midds	3	10	5	15	6	15
Wheat Flour	20	40	20	40	20	40
Wheat Germ	5	15	8	15	8	15
Wheat Screenings	10	20	12	25	15	30
Wheat Shorts	6	15	8	15	8	20
Yeast Alcohol Distillery	2	3	3	4	3	4
Yeast Brewery	2	3	3	4	3	4

Table 17 - Practical (Pr) and Maximum (Máx) Inclusion Levels of Feedstuffs in Growing and Breeders Swine Diets (percentage in the diet)

Feedstuffs	Growing Swine						Breeders			
	Starter		Grower		Finisher		Gestation		Lactation	
	Pr	Max	Pr	Max	Pr	Max	Pr	Max	Pr	Max
Bakery Cracker Res.	8	15	10	20	15	30	10	20	10	20
Blood Meal	1	2	1	3	2	4	2	4	1	3
Canola Meal	2	4	5	8	10	15	10	20	5	10
Carob Meal	3	6	5	8	7	10	7	10	5	8
Cassava w Hulls Dried	10	20	15	30	15	30	15	30	15	30
Citrus Pulp	-	2	3	5	4	6	5	8	2	5
Coconut Meal	2	5	4	7	5	8	5	10	4	7
Corn	60	60	65	65	70	70	65	65	70	70
Corn Germ	10	15	20	30	30	40	30	40	20	30
Corn Gluten Meal (21%)	3	8	4	10	5	10	5	12	4	8
Corn Gluten Meal(60%)	3	8	4	10	5	10	5	10	4	8
Corn High Lysine	60	60	65	65	70	70	65	65	70	70
Corn High Oil	50	60	65	65	70	70	50	65	70	70
Cottonseed Meal (30)	2	4	4	7	5	8	5	8	3	6
Cottonseed Meal (39)	3	5	5	8	6	10	6	10	5	8
Fat Poult, Cocot, Lard	2	5	2	5	2	5	-	4	2	5
Fat Tallow	2	4	2	5	2	5	-	4	2	5
Feather & Poult.B-P Meal	1	2	2	4	2	5	2	5	2	4
Feather Meal	1	2	2	4	2	5	2	5	2	4
Fish Meal	5	12	5	10	5	5	5	10	5	10
Meat & Bone Meal ( 51)	4	6	4	7	4	8	4	8	4	8
Meat & Bone Meal (41)	3	5	4	6	4	7	4	7	4	7
Millet	20	40	30	50	40	60	40	60	30	50

Table 17 - Practical (Pr) and Maximum (Máx) Inclusion Levels of Feedstuffs in Growing and Breeders Swine Diets (percentage in the diet)

Feedstuffs	Swine growing						Breeders			
	Starter		Grower		Finisher		Gestation		Lactation	
	Pr	Max	Pr	Max	Pr	Max	Pr	Max	Pr	Max
Oil Vegetable /Plant	2	5	2	5	2	5	-	4	2	5
Pasta-Spaghetti Res	10	15	15	25	20	30	20	30	20	30
Peanut Meal	4	7	6	10	6	10	6	10	6	10
Poultry By-Prod. Meal	3	5	4	7	4	8	4	8	4	8
Rice Bran	4	10	7	15	10	20	10	20	5	15
Rice Bran Defatted	3	8	5	12	7	20	10	20	5	12
Rice Broken	30	30	40	40	40	40	40	40	40	40
Sorghum High Tannin	15	30	20	35	20	35	20	35	20	35
Sorghum Low Tannin	30	60	35	65	35	70	35	65	35	70
Soybean Full-Fat Extr.	10	25	10	25	10	25	5	25	10	30
Soybean Full-Fat Toast	5	20	10	20	10	20	5	25	10	30
Soybean Hulls	-	-	-	3	-	5	5	12	-	5
Soybean Meal (45%)	30	30	25	25	20	20	15	15	25	25
Soybean Meal (48%)	30	30	25	25	20	20	15	15	25	25
Soybean Micronized	10	25	10	25	10	25	5	25	10	30
Sugar Molass. Dried	1	2	2	3	2	3	2	3	2	3
Sugarcane	2	10	-	10	-	10	-	10	2	10
Sugarcane Molasses	2	3	2	5	2	5	2	5	2	5
Sweet Potato Dried	2	5	5	10	6	12	6	12	5	8
Swine By-Prod. Meal	3	5	4	6	4	7	4	7	4	7
Triticale	10	25	20	35	20	35	20	35	20	35
Wheat	10	25	20	35	20	35	20	35	20	35
Wheat Bran-Midds	2	5	5	12	8	15	15	35	5	15
Wheat Flour	20	40	20	40	20	40	20	40	20	40
Wheat Germ	10	20	15	30	15	30	15	35	15	35
Wheat Screenings	10	20	15	30	15	30	15	30	15	30
Wheat Shorts	8	15	15	30	15	30	20	40	15	35
Yeast Alcohol Dist.	2	6	3	8	4	12	3	10	4	10
Yeast Brewery	2	8	4	10	4	15	4	15	4	10

Table 18 - Variation in Nutrient Content of Primary Feedstuffs - Crude Protein, Calcium and Phosphorus. (as fed)

Feedstuffs	Crude protein			Calcium			Phosphorus		
	Mean %	St. Dev.%	n	Mean %	St. Dev.%	n	Mean %	St. Dev.%	n
Corn	8.26	0.90	1493	0.03	0.03	252	0.24	0.05	233
Feather Meal (84%)	83.90	2.95	461	0.29	0.12	22	0.74	0.15	20
Fish Meal (54%)	54.40	4.59	73	5.90	1.75	43	2.41	0.80	41
Meat & Bone Meal (41%)	41.00	0.63	136	10.08	1.32	53	6.80	1.22	54
Meat & Bone Meal (45%)	44.54	1.13	111	9.55	1.32	47	4.96	1.22	54
Poultry By-Product Meal	57.00	5.84	1186	4.00	1.86	17	2.66	0.77	17
Rice Bran	13.24	1.96	236	0.11	0.065	46	1.81	0.42	45
Sorghum Low Tannin	9.23	1.35	355	0.03	0.045	43	0.26	0.060	55
Soybean Full-fat Extr./ Toast	37.00	1.03	422	0.23	0.14	44	0.52	0.05	41
Soybean Meal (45%)	45.32	1.15	1605	0.24	0.07	125	0.53	0.09	132
Wheat Bran-Midds	15.52	1.65	350	0.14	0.07	72	0.99	0.25	63
Dicalcium Phosphate				24.50	1.43	135	18.50	0.94	148
Limestone				38.40	1.23	61			

n=number of observations.

Table 19 - Variation in Nutrient Content of Primary Feedstuffs - Lysine, Methionine + Cystine and Threonine (as fed)

Feedstuffs	Lysine			Methionine + Cystine			Threonine		
	Mean %	St. Dev.%	n	Mean %	St. Dev.%	n	Mean %	St. Dev.%	n
Corn	0.24	0.045	1234	0.36	0.038	1214	0.32	0.043	1198
Feather Meal (84%)	2.40	0.30	451	4.05	0.51	451	3.66	0.22	450
Fish Meal (54%)	3.41	1.02	24	2.35	0.25	20	2.34	0.31	24
Meat & Bone Meal (41%)	1.98	0.18	110	0.80	0.16	105	1.15	0.20	110
Meat & Bone Meal (45%)	2.19	0.21	105	0.99	0.19	99	1.36	0.22	105
Poultry By-Product Meal	3.35	0.48	756	2.02	0.53	756	2.43	0.53	756
Rice Bran	0.63	0.11	191	0.52	0.06	186	0.49	0.10	191
Sorghum Low Tannin	0.20	0.036	271	0.32	0.033	265	0.31	0.048	271
Soybean Full-fat Extr./ Toast	2.23	0.11	357	1.08	0.05	352	1.47	0.08	357
Soybean Meal (45%)	2.77	0.10	1164	1.27	0.09	1145	1.78	0.10	1127
Wheat Bran-Midds	0.62	0.09	257	0.58	0.06	256	0.51	0.08	255

n=number of observations.



## **CHAPTER 2**

### **Nutritional Requirements of Poultry**





## INTRODUCTION

The following observations should be considered for a better understanding of the tables.

- \* Several factors may influence poultry requirements, such as breed, strain, sex, feed intake, dietary energy level, nutrient availability, environmental temperature, air humidity, health status, etc.
- \* Poultry nutritional requirements were determined in a series of dose-response trials carried out at the Universidade Federal de Viçosa (UFV), associated to observations of commercial herds in several Brazilian regions.
- \* For the determination of poultry nutritional requirements, basal diets were formulated using mainly corn and soybean meal. Therefore, when other ingredients are used, corrections as to nutrients digestibility or availability need to be made. This is the reason why requirements are expressed on true digestible amino acids
- \* Only the main nutrients are mentioned. The others are assumed as adequately supplied provided they are offered in amount equivalent to the vitamin and mineral supplements included in this publication.
- \* When birds are fed “*ad libitum*”, feed intake and particularly feed conversion largely depend on the energy level. Therefore, nutritional requirements of crude protein, calcium, phosphorus, potassium, sodium, chloride, and linoleic acid, were established according to the dietary metabolizable energy (ME) level and are expressed as a percentage per 1000 kcal ME in the diet. For replacement pullets, in addition to these nutrients, amino acids requirements were also included as percentage per 1000 kcal ME.

- \* Examples of nutritional requirements for poultry diets with energy levels normally used in Brazil were included. For other energy levels, just use the nutrient percentage per 1000 kcal ME ratio.
- \* High calcium and phosphorus levels must be avoided in broiler rations, as they may impair animal performance in addition to contributing to environmental pollution. Ca : total P ratio must be kept around 2:1 in the recommended levels. Nutritional requirements of sodium were estimated in several trials. For potassium, three experiments were performed. However, we decided to include also recommendations for potassium, sodium, and chloride for all birds in order to obtain adequate dietary electrolytic (cation - anion) balance.
- \* For layers and broiler breeders, requirements were established as amount of nutrient per day per bird for optimum performance. There is also an equation to determine daily ME requirement per hen. This equation takes into account data on body weight, daily weigh gain, egg mass, and environmental temperature. By using the figure obtained by the equation and the dietary energy level it is possible to estimate daily feed intake and to calculate the percentage of nutrients in the diet.
- \* It would be virtually impossible to establish one single energy level for each type of poultry diet. Dietary energy level varies according to the prices of the ingredients and of the chicken meat products. For instance, if vegetable oil or animal fat can be obtained at reasonable prices, higher energy levels can be used in the rations. On the other hand, if low energy feedstuffs are available at cheap prices, diets with lower dietary energy should be calculated. The main concern should not be to formulate only least cost feeds. It is more important to formulate a diet that allows the production of chicken meat and eggs at the lowest cost.

- \* The established protein levels should be assumed only as suggestions. These are minimum values for diets based on corn and soybean meal when the synthetic amino acids lysine, methionine, and threonine are offered. Excellent experimental and practical results have been obtained with lower protein diets by maintaining the recommended levels of essential amino acids, which are indeed the most important. The main objective is to reduce the impact on the environment of the excess of nutrients in the diets.
- \* In general, at the suggested protein levels, the requirements of glycine + serine, arginine, valine, isoleucine, leucine, histidine and phenylalanine + tyrosine are met.
- \* Amino acids must be close to the recommended levels. Excess of protein must also be avoided.
- \* Digestible methionine + cystine requirements were established based on a minimum of 55% sulfur amino acids supplied by methionine. As to phenylalanine + tyrosine requirements, the first must also supply at least 55% of the requirement. Serine and glycine are presented together as these amino acids are interchangeable.
- \* To estimate the nutritional requirements of the amino acids, lysine was used as reference. The lysine requirements were determined in several dose-response trials, run in the UFV with birds of different ages. The requirement of the other amino acids was then established using the concept of Ideal Protein maintaining for each type of bird the Amino Acid / Lysine Ratio, expressed on total and true digestibility basis.
- \* For broilers, firstly all dose-response experiments with lysine were compiled, and daily intake of digestible lysine was

determined. Then, lysine maintenance requirements were calculated and obtained the amount of digestible lysine / kg of gain, in the different growing phases. In these studies, the results of 30 dose-response experiments, 6 with females and 24 with males were used. Table 20 shows the methodology used to calculate the amount of true digestible lysine / kg of weight gain of broilers. The equation utilized to estimate the true digestible lysine of broiler chickens (males and females) according to the performance of the birds is presented in Table 21.

- \* The use of equations to estimate the true digestible lysine requirement of birds allows more flexibility, because in reality there is not a single requirement, but many as a function of performance and feed intake. As an example of the variation in lysine requirement, performance data of broilers (females and males) are shown and the daily lysine needs calculated. To make easier the manipulation of the Brazilian Tables, examples of requirements of broiler chickens with below average, standard and high performance are shown.
- \* For layers and broiler breeders, requirements are expressed as amount of nutrient per day per bird for optimal performance. An equation to calculate true digestible lysine requirement was estimated on the results of 11 dose-response experiments (Tables 37 and 52). As an example of the variation in lysine requirement, performance data of layers (white-egg and brown-egg) and broiler breeder hens, on which daily lysine requirement was calculated are shown. To facilitate the handling of the Brazilian Tables, examples are presented describing the nutritional requirements of layers and breeder hens with different body weight, daily gain, egg mass and feed intake.
- \* In nutritional requirements studies, the influence of high environmental temperature on broiler and layer performance was

clear. The main effect was a decrease in feed intake, caused by lower energy requirement for maintenance of birds grown at temperatures higher than 21°C (up to 27°C). There are correction factors to estimate the requirements of broilers, but examples are not mentioned, because if performance and feed intake are known, the optimal nutritional levels can be easily calculated using the tables shown in the text.

- \* For layers and broiler breeder hens, it was established that metabolizable energy requirement vary in 2 kcal ME per kilogram of body weight for each 1°C of environmental temperature below or above 21°C (Tables 38 and 53). This correction is adequate up to a limit of 27 °C, approximately.
- \* It is also important to have in mind that broiler and layer diets must contain adequate levels of xanthophylls for carcass and egg pigmentation.
- \* Simplified and practical tables of nutritional requirements are presented at the end of this publication (Chapter 4 - Tables 82 and 83), allowing a rapid and easy check of the nutritional levels commonly recommended for poultry in Brazil.



## **Nutritional Requirements of Broiler Chickens**





Table 20 - Methodology Used to Obtain the Equation that Calculates the True Digestible Lysine / kg Weight Gain of Broilers (Males and Females)

Age, days	1-11	1-21	22-40	41-56
Experiments at UFV <sup>1</sup>	2	13	10	5
Mean Weight in the Phase, kg	0.140	0.377	1.316	2.335
Feed Intake, g/day	25.1	48.4	136.1	194.4
Intake of Dig. Lys., g/day	0.3144	0.5622	1.3522	1.7698
Dig. Lys.Maintenance, g/day <sup>2</sup>	0.0229	0.0481	0.1229	0.1889
Dig. Lys. for Gain, g/day	0.2915	0.5140	1.229	1.5810
Average Gain, kg/day	0.0205	0.0343	0.0720	0.0820
g. Dig. Lys./ kg Gain	14.22	15.00	17.07	19.27
Equation, g Lys/ kg Gain	14.57	15.05	16.97	19.05

$$\text{Equation: } Y = 14.28 + 2.0439 X R^2 = 0.81$$

Being: Y = g Dig. Lys. / kg Gain; X = Average Weight, kg

<sup>1</sup> Total of 30 dose-response experiments with different lysine levels, being 6 with females and 24 with males.

<sup>2</sup> Daily requirement of digestible lysine for maintenance =  $0.1 \times (\text{Average weight})^{0.75}$ . Estimated from the values of Fisher, 1998 (Poultry Sci. 77:124) and of Edwards et.al., 1999 (Poultry Sci. 78:1412).

Table 21 - Equation Used to Estimate True Digestible Lysine (Dig. Lys.) Requirements of Broilers

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$$\text{Dig. Lys. (g/day)} = 0.1 \times W^{0.75} + (\text{g Dig. Lys. / kg Gain}) \times G$$

W = Average Body Weight in kg;

g Dig. Lys. / kg Gain =  $14.28 + 2.0439 (\text{Average Weight})$

G = Gain / Day in kg

Example:

Male Broilers of 36 to 42 days of age.

Average Weight = 2.198 kg being  $W^{0.75} = 1.805$

g Dig. Lys./kg Gain =  $14.28 + 2.0439 (2,198) = 18.772$

G. = 0.087 kg

Dig. Lys. Req. =  $0.1 \times 1.805 + (18.772 \times 0.087) = 1.814 \text{ g/day.}$

Estimated Intake = 178.4 g/day

% Dig. Lys. in the diet = 1.017%

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Table 22 - Digestible Lysine Requirement of of Broiler Males with Standard Performance Using the Equation of Table 21

Age day	Weight Kg	Gain g/day	Dig. Lys. Req. g/day	Intake g/day	ME Intake kcal/day <sup>1</sup>	Lys/ME Ratio%/Mcal	Dig. Lys. Diet %
0	0.042	--	--	--	--	--	--
1	0.074	13.4	0.207	15	43	0.481	1.419
2	0.088	15.2	0.235	17	50	0.470	1.382
3	0.103	17.1	0.265	20	58	0.457	1.350
4	0.120	19.1	0.297	23	66	0.451	1.321
5	0.139	21.2	0.332	26	76	0.437	1.295
6	0.160	23.5	0.368	29	85	0.433	1.273
7	0.184	25.9	0.407	32	96	0.424	1.252
8	0.210	28.3	0.447	36	109	0.411	1.234
9	0.238	30.9	0.490	40	121	0.405	1.218
10	0.269	33.5	0.534	44	133	0.401	1.203
11	0.302	36.2	0.580	49	146	0.397	1.190
12	0.338	38.9	0.627	53	160	0.392	1.179
13	0.377	41.7	0.675	58	173	0.390	1.168
14	0.419	44.5	0.725	63	188	0.386	1.159
15	0.463	47.2	0.776	67	202	0.384	1.150
16	0.511	50.0	0.827	72	217	0.381	1.143
17	0.561	52.8	0.879	77	232	0.379	1.136
18	0.614	55.5	0.931	82	247	0.377	1.129
19	0.669	58.2	0.984	88	263	0.374	1.123
20	0.727	60.8	1.037	93	278	0.373	1.118
21	0.788	63.3	1.089	98	294	0.370	1.113
22	0.851	65.7	1.141	103	319	0.358	1.108
23	0.917	68.0	1.193	108	335	0.356	1.103
24	0.985	70.3	1.244	113	351	0.354	1.099
25	1.055	72.4	1.294	118	366	0.353	1.095
26	1.128	74.3	1.342	123	382	0.351	1.090
27	1.202	76.2	1.390	128	397	0.350	1.086
28	1.278	77.9	1.436	133	412	0.349	1.081
29	1.356	79.5	1.481	138	426	0.348	1.077
30	1.436	80.9	1.524	142	441	0.346	1.072
31	1.516	82.2	1.565	147	455	0.344	1.067
32	1.599	83.3	1.604	151	468	0.343	1.062
33	1.682	84.3	1.641	155	482	0.341	1.056
34	1.766	85.1	1.676	160	495	0.339	1.051
35	1.851	85.8	1.709	164	507	0.337	1.045
36	1.937	86.4	1.740	168	528	0.330	1.038
37	2.024	86.8	1.768	171	540	0.327	1.032
38	2.110	87.1	1.794	175	552	0.325	1.025
39	2.197	87.2	1.818	179	563	0.323	1.017
40	2.285	87.2	1.839	182	574	0.320	1.010
41	2.372	87.1	1.857	185	584	0.318	1.002
42	2.459	86.9	1.873	189	594	0.315	0.993
43	2.546	86.5	1.887	192	614	0.307	0.984
44	2.632	86.1	1.899	195	623	0.305	0.975
45	2.718	85.5	1.908	198	632	0.302	0.966
46	2.804	84.9	1.915	200	641	0.299	0.956
47	2.889	84.1	1.919	203	649	0.296	0.946
48	2.973	83.3	1.922	205	658	0.292	0.935
49	3.056	82.4	1.922	208	665	0.289	0.924
50	3.139	81.4	1.920	210	673	0.285	0.913
51	3.220	80.3	1.916	212	680	0.282	0.902
52	3.300	79.2	1.911	215	687	0.278	0.890
53	3.380	78.1	1.903	217	693	0.275	0.879
54	3.458	76.9	1.894	219	699	0.271	0.867
55	3.534	75.6	1.883	220	705	0.267	0.854
56	3.610	75.0	1.885	222	711	0.265	0.848

<sup>1</sup> Rations containing 2950; 3000; 3100; 3150 and 3200 kcal ME/kg for the phases of 1-7; 8-21; 22-34; 35-42; 43-56 days of age.

Table 23 - Digestible Lysine Requirement of of Broiler Females with Standard Performance Using the Equation of Table 21

Age day	Weight kg	Gain g/day	Dig. Lys. Req. g/day	Intake g/day	ME Intake kcal/day <sup>1</sup>	Lys/ME Ratio%/Mcal	Dig. Lys.. Diet %
0	0.042	--	--	--	--	--	--
1	0.074	13.3	0.206	13	39	0.529	1.568
2	0.087	15.0	0.233	15	46	0.506	1.505
3	0.102	16.8	0.262	18	53	0.494	1.451
4	0.119	18.7	0.292	21	61	0.479	1.403
5	0.138	20.7	0.324	24	70	0.463	1.360
6	0.159	22.8	0.358	27	80	0.448	1.323
7	0.181	25.0	0.393	30	90	0.437	1.290
8	0.206	27.2	0.430	34	102	0.422	1.261
9	0.234	29.4	0.468	38	114	0.410	1.235
10	0.263	31.7	0.507	42	125	0.405	1.212
11	0.295	34.0	0.546	46	138	0.396	1.192
12	0.329	36.3	0.587	50	150	0.391	1.173
13	0.365	38.6	0.627	54	163	0.385	1.157
14	0.404	40.9	0.669	59	176	0.380	1.142
15	0.445	43.1	0.710	63	189	0.375	1.128
16	0.488	45.3	0.751	67	202	0.372	1.115
17	0.533	47.4	0.792	72	215	0.368	1.104
18	0.580	49.5	0.832	76	228	0.365	1.093
19	0.630	51.4	0.872	80	241	0.362	1.083
20	0.681	53.3	0.911	85	254	0.358	1.073
21	0.735	55.1	0.948	89	267	0.355	1.064
22	0.790	56.7	0.985	93	289	0.341	1.056
23	0.846	58.2	1.021	97	302	0.338	1.047
24	0.905	59.6	1.055	102	315	0.335	1.039
25	0.964	60.9	1.087	105	327	0.333	1.031
26	1.025	62.1	1.118	109	339	0.330	1.023
27	1.087	63.1	1.148	113	351	0.327	1.015
28	1.150	64.0	1.175	117	362	0.325	1.007
29	1.214	64.7	1.201	120	373	0.322	0.999
30	1.279	65.4	1.224	124	383	0.320	0.990
31	1.345	65.8	1.246	127	393	0.317	0.982
32	1.410	66.2	1.266	130	403	0.314	0.973
33	1.477	66.4	1.283	133	413	0.311	0.964
34	1.543	66.6	1.299	136	422	0.308	0.955
35	1.610	66.6	1.312	139	430	0.305	0.946
36	1.676	66.5	1.324	141	446	0.297	0.936
37	1.743	66.2	1.334	144	454	0.294	0.926
38	1.809	65.9	1.341	146	481	0.279	0.915
39	1.875	65.5	1.347	149	469	0.287	0.905
40	1.940	65.0	1.351	151	476	0.284	0.894
41	2.005	64.4	1.353	153	482	0.281	0.883
42	2.070	63.8	1.353	155	489	0.277	0.872
43	2.134	63.0	1.351	157	503	0.269	0.860
44	2.197	62.2	1.348	159	509	0.265	0.848
45	2.259	61.4	1.344	161	514	0.261	0.836
46	2.320	60.4	1.338	162	519	0.258	0.824
47	2.381	59.5	1.330	164	524	0.254	0.812
48	2.440	58.5	1.322	165	529	0.250	0.799
49	2.499	57.4	1.312	167	534	0.246	0.787
50	2.556	56.3	1.301	168	538	0.242	0.774
51	2.612	55.2	1.289	169	542	0.238	0.761
52	2.667	54.1	1.276	170	546	0.234	0.748
53	2.722	52.9	1.262	172	549	0.230	0.735
54	2.774	51.7	1.247	173	552	0.226	0.722
55	2.826	50.6	1.232	174	556	0.222	0.709
56	2.877	50.0	1.228	175	559	0.220	0.703

<sup>1</sup> Rations containing 2950; 3000; 3100; 3150 and 3200 kcal ME/kg for the phases of 1-7; 8-21; 22-34; 35-42; 43-56 days of age.

Table 24 - Amino Acid / Lysine Ratio Used to Estimate Amino Acid Requirements of Broiler Chickens

Amino Acid		Age, days					
		1 -21		22 - 42		43 - 56	
		Dig.	Total	Dig.	Total	Dig.	Total
Lysine	%	100	100	100	100	100	100
Methionine	%	39	39	40	40	40	40
Methionine + Cystine	%	71	71	72	72	72	72
Tryptophan	%	16	16	17	17	17	17
Threonine	%	65	68	65	68	65	68
Arginine	%	105	102	105	102	105	102
Glycine + Serine	%	-	150	-	140	-	135
Valine	%	75	76	77	78	77	78
Isoleucine	%	65	66	67	68	67	68
Leucine	%	108	108	109	109	109	109
Histidine	%	36	36	36	36	36	36
Phenylalanine	%	63	63	63	63	63	63
Phenylal. + Tyrosine	%	115	114	115	114	115	114

Table 25 - Equations Used to Estimate the Nutritional Requirements (Y) of Broilers, in % per Mcal ME as a Function of Age (X)<sup>1</sup>

Males	Females <sup>2</sup>
Crude Protein <sup>3</sup>	
$Y = 7.676 - 0.0514 X$	$Y = 7.295 - 0.0455 X$
Calcium	
$Y = 0.3273 - 0.00224 X$	$Y = 0.3106 - 0.00213 X$
Available Phosphorus	
$Y = 0.1637 - 0.00113 X$	$Y = 0.1562 - 0.00109 X$
Potassium	
$Y = 0.2027 - 0.000454 X$	$Y = 0.1932 - 0.000454 X$
Sodium	
$Y = 0.0773 - 0.00041 X$	$Y = 0.0732 - 0.00038 X$
Chloride	
$Y = 0.0694 - 0.00041 X$	$Y = 0.0665 - 0.00040 X$
Linoleic acid	
$Y = 0.3720 - 0.00134$	$Y = 0.3530 - 0.00128 X$

<sup>1</sup> In order to determine nutrient percentage in the diet of the chosen nutritional program, use the equations above. Y = nutrient % per 1.0 Mcal of ME/kg and X = bird average age (days). The value obtained must then be multiplied by dietary ME in Mcal; Ex.: Calcium requirements of male broilers in the period of 8 to 21 days (average age of 14.5 days) is:

$Y = 0.3273 - 0.00224 \cdot (14.5) = 0.295 \text{ \%}/\text{Mcal} \times 3.00 \text{ Mcal ME/kg diet} = 0.884\% \text{ of Calcium}$

<sup>2</sup> Nutrient level suggested for females corresponds approximately to 95% of males requirements.

<sup>3</sup> Minimum protein levels for diets based on corn and soybean meal when the synthetic amino acids lysine, methionine and threonine are available.

Table 26 - Nutritional Requirements of Broiler Males with Below Average Performance<sup>1</sup>

		Age. days				
		1-7	8-21	22-33	34-42	43-46
Average Weight	Kg.	0.120	0.435	1.250	2.066	2.515
Weight Gain	g/day	18.5	40.5	74.1	82.0	80.6
Intake	g/day	22.2	60.0	130.2	170.3	190.0
Dig. Lys Requirement.	g/day	0.289	0.668	1.366	1.690	1.765
		Nutrient				
Metabolizable Energy	Kcal/kg	2.925	2.980	3.050	3.100	3.150
Protein	%	21.85	20.65	19.10	17.74	16.97
Calcium	%	0.931	0.878	0.810	0.751	0.717
Available Phosphorus	%	0.466	0.439	0.405	0.374	0.357
Potassium	%	0.587	0.584	0.580	0.575	0.575
Sodium	%	0.221	0.213	0.201	0.191	0.186
Chloride	%	0.198	0.189	0.177	0.167	0.161
Linoleic Acid	%	1.072	1.051	1.022	0.995	0.984
		Digestible Amino Acid				
Lysine	%	1.302	1.113	1.049	0.992	0.929
Methionine	%	0.508	0.434	0.420	0.397	0.372
Methionine + Cystine	%	0.924	0.790	0.755	0.714	0.669
Tryptophan	%	0.208	0.178	0.178	0.169	0.158
Threonine	%	0.846	0.723	0.682	0.645	0.604
Arginine	%	1.367	1.169	1.101	1.042	0.975
Valine	%	0.977	0.835	0.808	0.764	0.715
Isoleucine	%	0.846	0.723	0.703	0.665	0.622
Leucine	%	1.406	1.202	1.143	1.081	1.013
Histidine	%	0.469	0.401	0.378	0.357	0.334
Phenylalanine	%	0.820	0.701	0.661	0.625	0.585
Phenylalanine + Tyrosine	%	1.497	1.280	1.206	1.141	1.068
		Total Amino Acid				
Lysine	%	1.435	1.227	1.157	1.094	1.024
Methionine	%	0.560	0.479	0.463	0.438	0.410
Methionine + Cystine	%	1.019	0.871	0.833	0.788	0.737
Tryptophan	%	0.230	0.196	0.197	0.186	0.174
Threonine	%	0.976	0.834	0.787	0.744	0.696
Arginine	%	1.464	1.252	1.180	1.116	1.044
Glycine + Serine	%	2.153	1.841	1.620	1.532	1.382
Valine	%	1.091	0.933	0.902	0.853	0.799
Isoleucine	%	0.947	0.810	0.787	0.744	0.696
Leucine	%	1.550	1.325	1.261	1.192	1.116
Histidine	%	0.517	0.442	0.417	0.394	0.369
Phenylalanine	%	0.904	0.773	0.729	0.689	0.645
Phenylalanine + Tyrosine	%	1.636	1.399	1.319	1.247	1.167

<sup>1</sup> Nutrient percentage was determined using: Table 21 (Dig. Lys. requirement according to performance), Table 24 (Amino acid / lysine ratios), and Table 25 (Equations - % nutrient / Mcal. ME). Total lysine requirement was calculated considering the average true lysine digestibility of 90.7%.

Table 27 - Nutritional Requirements of Broiler Males with Standard Performance<sup>1</sup>

		Age. days				
		1-7	8-21	22-33	34-42	43-46
Averageweight	Kg.	0.124	0.463	1.330	2.198	2.675
Weight Gain	g/day	19.6	45.8	77.6	87.0	85.7
Intake	g/day	23.0	65.8	134.5	178.4	196.1
Dig. Lys Requirement	g/day	0.306	0.754	1.443	1.814	1.902
		Nutrient				
Metabolizable Energy	kcal/kg	2.950	3.000	3.100	3.150	3.200
Protein	%	22.04	20.79	19.41	18.03	17.24
Calcium	%	0.939	0.884	0.824	0.763	0.728
Available phosphorus	%	0.470	0.442	0.411	0.380	0.363
Potassium	%	0.593	0.588	0.590	0.584	0.584
Sodium	%	0.223	0.214	0.205	0.194	0.189
Chloride	%	0.200	0.190	0.180	0.170	0.164
Linoleic Acid	%	1.081	1.058	1.039	1.011	0.999
		Digestible Amino Acid				
Lysine	%	1.330	1.146	1.073	1.017	0.970
Methionine	%	0.519	0.447	0.429	0.407	0.388
Methionine + Cystine	%	0.944	0.814	0.773	0.732	0.698
Tryptophan	%	0.213	0.183	0.182	0.173	0.165
Threonine	%	0.865	0.745	0.697	0.661	0.631
Arginine	%	1.397	1.203	1.127	1.068	1.019
Valine	%	0.998	0.860	0.826	0.783	0.747
Isoleucine	%	0.865	0.745	0.719	0.681	0.650
Leucine	%	1.436	1.238	1.170	1.109	1.057
Histidine	%	0.479	0.413	0.386	0.366	0.349
Phenylalanine	%	0.838	0.722	0.676	0.641	0.611
Phenylalanine + Tyrosine	%	1.530	1.318	1.234	1.170	1.116
		Total Amino Acid				
Lysine	%	1.466	1.263	1.183	1.121	1.069
Methionine	%	0.572	0.493	0.473	0.448	0.428
Methionine + Cystine	%	1.041	0.897	0.852	0.807	0.770
Tryptophan	%	0.235	0.202	0.201	0.191	0.182
Threonine	%	0.997	0.859	0.804	0.762	0.727
Arginine	%	1.495	1.288	1.207	1.143	1.090
Glycine + Serine	%	2.199	1.895	1.656	1.569	1.443
Valine	%	1.114	0.960	0.923	0.874	0.834
Isoleucine	%	0.968	0.834	0.804	0.762	0.727
Leucine	%	1.583	1.364	1.289	1.222	1.165
Histidine	%	0.528	0.455	0.426	0.404	0.385
Phenylalanine	%	0.924	0.796	0.745	0.706	0.673
Phenylalanine + Tyrosine	%	1.671	1.440	1.349	1.278	1.219

<sup>1</sup> Nutrient percentage was determined using: Table 21 (Dig. Lys. requirement according to performance), Table 24 (Amino acid / lysine ratios), and Table 25 (Equations - % nutrient / Mcal. ME). Total lysine requirement was calculated considering the average true lysine digestibility of 90.7%..



Table 28 - Nutritional Requirements of Broiler Males with High Performance<sup>1</sup>

		Age, Days				
		1-7	8-21	22-33	34-42	43-46
Average Weight	Kg.	0.130	0.490	1.438	2.380	2.900
Weight Gain	g/day	21.0	48.3	82.4	94.0	93.0
Intake	g/day	24.0	67.0	141.0	190.0	207.0
Dig. Lys Requirement	g/day	0.327	0.797	1.550	1.991	2.101
		Nutrient				
Metabolizable Energy	kcal/kg	2.960	3.050	3.150	3.200	3.250
Protein	%	22.11	21.14	19.73	18.31	17.51
Calcium	%	0.942	0.899	0.837	0.775	0.740
Available phosphorus	%	0.471	0.449	0.418	0.386	0.368
Potassium	%	0.595	0.598	0.599	0.593	0.593
Sodium	%	0.224	0.218	0.208	0.198	0.192
Chloride	%	0.200	0.193	0.183	0.172	0.166
Linoleic Acid	%	1.085	1.075	1.056	1.027	1.015
		Digestible Amino Acid				
Lysine	%	1.363	1.189	1.099	1.048	1.015
Methionine	%	0.532	0.464	0.440	0.419	0.406
Methionine + Cystine	%	0.968	0.844	0.791	0.755	0.731
Tryptophan	%	0.218	0.190	0.187	0.178	0.173
Threonine	%	0.886	0.773	0.714	0.681	0.660
Arginine	%	1.431	1.248	1.154	1.100	1.066
Valine	%	1.022	0.892	0.846	0.807	0.782
Isoleucine	%	0.886	0.773	0.736	0.702	0.680
Leucine	%	1.472	1.284	1.198	1.142	1.106
Histidine	%	0.491	0.428	0.396	0.377	0.365
Phenylalanine	%	0.859	0.749	0.692	0.660	0.639
Phenylalanine + Tyrosine	%	1.567	1.367	1.264	1.205	1.167
		Total Amino Acid				
Lysine	%	1.503	1.311	1.212	1.155	1.119
Methionine	%	0.586	0.511	0.485	0.462	0.448
Methionine + Cystine	%	1.067	0.931	0.873	0.832	0.806
Tryptophan	%	0.240	0.210	0.206	0.196	0.190
Threonine	%	1.022	0.891	0.824	0.785	0.761
Arginine	%	1.533	1.337	1.236	1.178	1.141
Glycine + Serine	%	2.255	1.966	1.697	1.617	1.511
Valine	%	1.142	0.996	0.945	0.901	0.873
Isoleucine	%	0.992	0.865	0.824	0.785	0.761
Leucine	%	1.623	1.416	1.321	1.259	1.220
Histidine	%	0.541	0.472	0.436	0.416	0.403
Phenylalanine	%	0.947	0.826	0.764	0.728	0.705
Phenylalanine + Tyrosine	%	1.013	1.495	1.382	1.317	1.276

<sup>1</sup> Nutrient percentage was determined using: Table 21 (Dig. Lys. requirement according to performance), Table 24 (Amino acid / lysine ratios), and Table 25 (Equations - % nutrient / Mcal. ME). Total lysine requirement was calculated considering the average true lysine digestibility of 90.7%.

Table 29 - Nutritional Requirements of Broiler Females with Below Average Performance<sup>1</sup>

		Age. Days				
		1-7	8-21	22-33	34-42	43-46
Average weight	Kg.	0.116	0.416	1.130	1.790	2.080
Weight Gain	g/day	17.5	36.1	60.0	62.0	59.5
Intake	g/day	21.1	55.6	114.0	143.0	156.0
Dig. Lys Requirement	g/day	0.274	0.598	1.105	1.267	1.276
		Nutrient				
Metabolizable Energy	kcal/kg	2.925	2.980	3.050	3.100	3.150
Protein	%	20.80	19.77	18.43	17.25	16.60
Calcium	%	0.883	0.833	0.769	0.712	0.680
Available phosphorus	%	0.444	0.418	0.385	0.356	0.339
Potassium	%	0.560	0.556	0.551	0.545	0.545
Sodium	%	0.210	0.202	0.191	0.182	0.177
Chloride	%	0.190	0.181	0.169	0.159	0.153
Linoleic Acid	%	1.017	0.997	0.969	0.944	0.933
		Digestible Amino Acid				
Lysine	%	1.299	1.076	0.969	0.886	0.818
Methionine	%	0.507	0.420	0.388	0.354	0.327
Methionine + Cystine	%	0.922	0.764	0.698	0.638	0.589
Tryptophan	%	0.208	0.172	0.165	0.151	0.139
Threonine	%	0.844	0.699	0.630	0.576	0.532
Arginine	%	1.364	1.130	1.017	0.930	0.859
Valine	%	0.974	0.807	0.746	0.682	0.630
Isoleucine	%	0.844	0.699	0.649	0.594	0.548
Leucine	%	1.403	1.162	1.056	0.966	0.892
Histidine	%	0.468	0.387	0.349	0.319	0.294
Phenylalanine	%	0.818	0.678	0.610	0.558	0.515
Phenylalanine + Tyrosine	%	1.494	1.237	1.114	1.019	0.941
		Total Amino Acid				
Lysine	%	1.479	1.186	1.123	1.032	0.963
Methionine	%	0.577	0.463	0.449	0.413	0.385
Methionine + Cystine	%	1.050	0.842	0.809	0.743	0.693
Tryptophan	%	0.237	0.190	0.191	0.175	0.164
Threonine	%	1.006	0.806	0.764	0.702	0.655
Arginine	%	1.509	1.210	1.145	1.053	0.982
Glycine + Serine	%	2.218	1.779	1.572	1.445	1.300
Valine	%	1.124	0.901	0.876	0.805	0.751
Isoleucine	%	0.976	0.783	0.764	0.702	0.655
Leucine	%	1.597	1.281	1.224	1.125	1.050
Histidine	%	0.532	0.427	0.404	0.372	0.347
Phenylalanine	%	0.932	0.747	0.707	0.650	0.607
Phenylalanine + Tyrosine	%	1.686	1.352	1.280	1.176	1.098

<sup>1</sup> Nutrient percentage was determined using: Table 21 (Dig. Lys. requirement according to performance), Table 24 (Amino acid / lysine ratios), and Table 25 (Equations - % nutrient / Mcal. ME). Total lysine requirement was calculated considering the average true lysine digestibility of 90.7%.

Table 30 - Nutritional Requirements of Broiler Females with Standad Performance<sup>1</sup>

		Age. days				
		1-7	8-21	22-33	34-42	43-46
Average Weight	Kg.	0.123	0.442	1.189	1.874	2.228
Weight Gain	g/day	18.9	41.7	63.3	65.3	63.0
Intake	g/day	22.5	61.1	117.5	148.6	159.8
Dig. Lys Requirement	g/day	0.296	0.688	1.172	1.343	1.369
		Nutrient				
Metabolizable Energy	kcal/kg	2.950	3.000	3.100	3.150	3.200
Protein	%	20.98	19.90	18.74	17.53	16.86
Calcium	%	0.891	0.839	0.781	0.723	0.691
Available phosphorus	%	0.448	0.421	0.391	0.362	0.345
Potassium	%	0.564	0.560	0.560	0.554	0.553
Sodium	%	0.211	0.203	0.195	0.185	0.180
Chloride	%	0.191	0.182	0.172	0.162	0.156
Linoleic Acid	%	1.040	1.003	0.985	0.959	0.947
		Digestible Amino Acid				
Lysine	%	1.316	1.126	0.997	0.904	0.857
Methionine	%	0.513	0.439	0.399	0.362	0.343
Methionine + Cystine	%	0.934	0.799	0.718	0.651	0.617
Tryptophan	%	0.211	0.180	0.169	0.154	0.146
Threonine	%	0.855	0.732	0.648	0.588	0.557
Arginine	%	1.382	1.182	1.047	0.949	0.900
Valine	%	0.987	0.845	0.768	0.696	0.660
Isoleucine	%	0.855	0.732	0.668	0.606	0.574
Leucine	%	1.421	1.216	1.087	0.985	0.934
Histidine	%	0.474	0.405	0.359	0.325	0.309
Phenylalanine	%	0.829	0.709	0.628	0.570	0.540
Phenylalanine + Tyrosine	%	1.513	1.295	1.147	1.040	0.986
		Total Amino Acid				
Lysine	%	1.450	1.241	1.099	0.997	0.945
Methionine	%	0.566	0.484	0.440	0.399	0.378
Methionine + Cystine	%	1.030	0.881	0.791	0.718	0.680
Tryptophan	%	0.232	0.199	0.187	0.169	0.161
Threonine	%	0.986	0.844	0.747	0.678	0.643
Arginine	%	1.479	1.266	1.121	1.017	0.964
Glycine + Serine	%	2.175	1.862	1.539	1.396	1.276
Valine	%	1.102	0.943	0.857	0.778	0.737
Isoleucine	%	0.957	0.819	0.747	0.678	0.643
Leucine	%	1.566	1.340	1.198	1.087	1.030
Histidine	%	0.522	0.447	0.396	0.359	0.340
Phenylalanine	%	0.914	0.782	0.692	0.628	0.595
Phenylalanine + Tyrosine	%	1.653	1.415	1.253	1.137	1.077

<sup>1</sup> Nutrient percentage was determined using: Table 21 (Dig. Lys. requirement according to performance), Table 24 (Amino acid / lysine ratios), and Table 25 (Equations - % nutrient / Mcal. ME). Total lysine requirement was calculated considering the average true lysine digestibility of 90.7%.

Table 31 - Nutritional Requirements of Broiler Females with High Performance<sup>1</sup>

		Age. Days				
		1-7	8-21	22-33	34-42	43-46
Average Weight	Kg.	0.128	0.473	1.278	1.990	2.405
Weight Gain	g/day	20.2	43.8	67.1	71.0	69.0
Intake	g/day	23.7	63.0	123.0	156.6	168.3
Dig. Lys Requirement.	g/day	0.315	0.725	1.254	1.470	1.518
		Nutrient				
Metabolizable Energy	kcal/kg	2.960	3.050	3.150	3.200	3.250
Protein	%	21.05	20.24	19.04	17.81	17.13
Calcium	%	0.894	0.853	0.794	0.735	0.701
Available Phosphorus	%	0.450	0.428	0.398	0.367	0.350
Potassium	%	0.566	0.569	0.569	0.563	0.562
Sodium	%	0.212	0.206	0.198	0.188	0.183
Chloride	%	0.192	0.185	0.175	0.164	0.158
Linoleic Acid	%	1.030	1.020	1.001	0.974	0.962
		Digestible Amino Acid				
Lysine	%	1.330	1.151	1.020	0.939	0.902
Methionine	%	0.519	0.449	0.408	0.376	0.361
Methionine + Cystine	%	0.944	0.817	0.734	0.676	0.649
Tryptophan	%	0.213	0.184	0.173	0.160	0.153
Threonine	%	0.865	0.748	0.663	0.610	0.586
Arginine	%	1.397	1.208	1.071	0.986	0.947
Valine	%	0.998	0.863	0.785	0.723	0.695
Isoleucine	%	0.865	0.748	0.683	0.629	0.604
Leucine	%	1.436	1.242	1.112	1.024	0.983
Histidine	%	0.479	0.414	0.367	0.338	0.325
Phenylalanine	%	0.838	0.725	0.643	0.592	0.568
Phenylalanine + Tyrosine	%	1.530	1.323	1.173	1.080	1.037
		Total Amino Acid				
Lysine	%	1.466	1.268	1.125	1.035	0.994
Methionine	%	0.572	0.495	0.450	0.414	0.398
Methionine + Cystine	%	1.041	0.900	0.810	0.745	0.716
Tryptophan	%	0.235	0.203	0.191	0.176	0.169
Threonine	%	0.997	0.862	0.765	0.704	0.676
Arginine	%	1.495	1.293	1.148	1.056	1.014
Glycine + Serine	%	2.199	1.902	1.575	1.449	1.342
Valine	%	1.114	0.964	0.878	0.807	0.775
Isoleucine	%	0.968	0.837	0.765	0.704	0.676
Leucine	%	1.583	1.369	1.226	1.128	1.083
Histidine	%	0.528	0.456	0.405	0.373	0.358
Phenylalanine	%	0.924	0.799	0.709	0.652	0.626
Phenylalanine + Tyrosine	%	1.671	1.446	1.283	1.180	1.133

<sup>1</sup> Nutrient percentage was determined using: Table 21 (Dig. Lys. requirement according to performance), Table 24 (Amino acid / lysine ratios), and Table 25 (Equations - % nutrient / Mcal. ME). Total lysine requirement was calculated considering the average true lysine digestibility of 90.7%.

## **Nutritional Requirements of Replacement Pullets and Layers**



Table 32 - Amino Acid / Lysine Ratio Used to Estimate Amino Acid Requirements of White-Egg and Brown-Egg Replacement Pullets

Phase	Starter		Grower		Developer	
Age (weeks)	1- 6		7 - 12		13 - 18	
Amino acid	Dig.	Total	Dig.	Total	Dig.	Total
Lysine	100	100	100	100	100	100
Methionine	40	40	44	44	45	45
Methionine + Cystine	73	73	80	80	82	83
Tryptophan	18	18	20	20	22	22
Threonine	67	70	68	71	69	72
Arginine	107	105	108	106	110	107
Glycine + Serine	-	130	-	120	-	110
Valine	76	78	80	81	82	83
Isoleucine	69	70	75	76	77	78
Leucine	112	111	118	117	125	124
Histidine	37	37	38	38	39	39
Phenylalanine	66	66	69	69	72	72
Phenylalanine + Tyrosine	121	120	125	125	130	130

Table 33 - Nutritional Requirements of White-Egg Replacement Pullets (% per 1000 kcal ME diet)<sup>1</sup>

Phase		Starter		Grower		Developer	
Age (weeks)		1- 6		7 - 12		13 - 18	
Crude Protein	%	6,21		5,52		4,83	
Calcium	%	0,324		0,287		0,276	
Available Phosphorus	%	0,151		0,135		0,107	
Potassium	%	0,183		0,179		0,172	
Sodium	%	0,062		0,055		0,052	
Chloride	%	0,055		0,052		0,048	
Linoleic acid	%	0,354		0,345		0,338	
Amino acid		Dig.	Total	Dig.	Total	Dig.	Total
Lysine	%	0,302	0,336	0,214	0,238	0,166	0,185
Methionine	%	0,121	0,134	0,094	0,105	0,075	0,083
Methionine + Cystine	%	0,221	0,245	0,171	0,190	0,136	0,154
Tryptophan	%	0,054	0,060	0,043	0,048	0,036	0,041
Threonine	%	0,202	0,235	0,146	0,169	0,115	0,133
Arginine	%	0,323	0,352	0,231	0,252	0,183	0,198
Glycine + Serine	%	-	0,436	-	0,286	-	0,204
Valine	%	0,230	0,262	0,171	0,193	0,136	0,154
Isoleucine	%	0,208	0,235	0,161	0,181	0,128	0,144
Leucine	%	0,338	0,372	0,253	0,278	0,208	0,230
Histidine	%	0,112	0,124	0,081	0,090	0,065	0,072
Phenylalanine	%	0,199	0,221	0,148	0,164	0,120	0,133
Phenylal. + Tyrosine	%	0,366	0,403	0,268	0,298	0,216	0,241

<sup>1</sup> To determine nutrient percentage in the diet, multiply the requirements in the table above by the dietary ME in Mcal; Ex.: Dig. Lysine for birds in the starter phase, diet containing 2.9 Mcal / kg x 0.302 = 0.876 %. Total lysine requirement was calculated considering the average true lysine digestibility of 90%.



Table 34 - Nutritional Requirements of Brown-Egg Replacement Pullets (% per 1000 kcal ME diet)<sup>1</sup>

Phase		Starter		Grower		Developer	
Age (weeks)		1- 6		7 - 12		13 - 18	
Crude Protein	%	6,21		5,52		4,83	
Calcium	%	0,324		0,281		0,269	
Available Phosphorus	%	0,148		0,132		0,107	
Potassium	%	0,183		0,179		0,172	
Sodium	%	0,062		0,055		0,052	
Chloride	%	0,055		0,052		0,048	
Linoleic acid	%	0,360		0,355		0,351	
Amino acid		Dig.	Total	Dig.	Total	Dig.	Total
Lysine	%	0,292	0,325	0,211	0,234	0,161	0,179
Methionine	%	0,117	0,130	0,093	0,103	0,072	0,081
Methionine + Cystine	%	0,213	0,237	0,169	0,187	0,132	0,149
Tryptophan	%	0,053	0,059	0,042	0,047	0,036	0,039
Threonine	%	0,196	0,228	0,143	0,166	0,111	0,129
Arginine	%	0,313	0,341	0,228	0,248	0,177	0,191
Glycine + Serine	%	-	0,423	-	0,281	-	0,197
Valine	%	0,222	0,254	0,169	0,190	0,132	0,149
Isoleucine	%	0,202	0,228	0,158	0,178	0,124	0,140
Leucine	%	0,328	0,361	0,249	0,274	0,201	0,222
Histidine	%	0,108	0,120	0,080	0,089	0,063	0,070
Phenylalanine	%	0,193	0,214	0,146	0,162	0,116	0,129
Phenylal. + Tyrosine	%	0,354	0,390	0,263	0,293	0,209	0,233

<sup>1</sup> To determine nutrient percentage in the diet, multiply the requirements in the table above by the dietary ME in Mcal; Ex.: Dig. Lysine for birds in the starter phase, diet containing 2.9 Mcal / kg x 0.292 = 0.847%. Total lysine requirement was calculated considering the average true lysine digestibility of 90%.

Table 35 - Nutritional Requirements of White-Egg Replacement Pullets According to Dietary Energy Level<sup>1</sup>

Phase		Starter		Grower		Developer	
Age (weeks)		1- 6		7 - 12		13 - 18	
Met. Energy kcal/kg		2.900		2.900		2.900	
Crude Protein	%	18,00		16,0		14,0	
Calcium	%	0,940		0,832		0,800	
Available Phosphorus	%	0,437		0,392		0,310	
Potassium	%	0,530		0,520		0,500	
Sodium	%	0,180		0,160		0,150	
Chloride	%	0,160		0,150		0,140	
Linoleic acid	%	1,027		1,000		0,980	
Amino acid		Dig.	Total	Dig.	Total	Dig.	Total
Lysine	%	0,876	0,973	0,621	0,690	0,483	0,537
Methionine	%	0,350	0,389	0,273	0,304	0,217	0,242
Methionine + Cystine	%	0,640	0,710	0,497	0,552	0,396	0,446
Tryptophan	%	0,158	0,175	0,124	0,138	0,106	0,118
Threonine	%	0,587	0,681	0,422	0,490	0,333	0,387
Arginine	%	0,937	1,022	0,671	0,731	0,531	0,575
Glycine + Serine	%	-	1,265	-	0,828	-	0,591
Valine	%	0,666	0,759	0,497	0,559	0,396	0,446
Isoleucine	%	0,604	0,681	0,466	0,524	0,372	0,419
Leucine	%	0,981	1,080	0,733	0,807	0,604	0,666
Histidine	%	0,324	0,360	0,236	0,262	0,188	0,209
Phenylalanine	%	0,578	0,642	0,429	0,476	0,348	0,387
Phenylal. + Tyrosine	%	1,060	1,168	0,776	0,863	0,628	0,698

<sup>1</sup> To determine nutrient percentage in the diet, multiply the requirements in table 33 by dietary the ME in Mcal; Ex.: Dig. Lysine for birds in the starter phase, diet containing 2.9 Mcal / kg x 0.302 = 0.876%.

Table 36 - Nutritional Requirements of Brown-Egg Replacement Pullets According to Dietary Energy Level<sup>1</sup>

Phase		Starter		Grower		Developer	
Age (weeks)		1- 6		7 - 12		13 - 18	
Met Energy kcal/kg		2.900		2.900		2.900	
Crude Protein	%	18,00		16,00		14,00	
Calcium	%	0,940		0,815		0,780	
Available Phosphorus	%	0,430		0,383		0,310	
Potassium	%	0,530		0,520		0,500	
Sodium	%	0,180		0,160		0,150	
Chloride	%	0,160		0,150		0,140	
Linoleic acid	%	1,044		1,030		1,018	
Amino acid		Dig.	Total	Dig.	Total	Dig.	Total
Lysine	%	0,847	0,943	0,611	0,679	0,467	0,519
Methionine	%	0,339	0,377	0,269	0,299	0,210	0,234
Methionine + Cystine	%	0,619	0,688	0,489	0,543	0,383	0,431
Tryptophan	%	0,153	0,170	0,122	0,136	0,103	0,114
Threonine	%	0,568	0,660	0,416	0,482	0,322	0,374
Arginine	%	0,907	0,990	0,660	0,720	0,514	0,555
Glycine + Serine	%	-	1,226	-	0,815	-	0,571
Valine	%	0,645	0,736	0,489	0,550	0,383	0,431
Isoleucine	%	0,585	0,660	0,458	0,516	0,360	0,405
Leucine	%	0,950	1,047	0,721	0,794	0,584	0,644
Histidine	%	0,314	0,349	0,232	0,258	0,182	0,202
Phenylalanine	%	0,560	0,622	0,422	0,469	0,336	0,374
Phenylal. + Tyrosine	%	1,026	1,132	0,764	0,849	0,607	0,675

<sup>1</sup> To determine nutrient percentage in the diet, multiply the requirements in table 34 by the dietary ME in Mcal; Ex.: Dig. Lysine for birds in the starter phase, diet containing 2.9 Mcal / kg x 0.292 (Table 33) = 0.847% %.

Table 37 - Equation Used to Estimate True Digestible Lysine (Dig. Lys.) Requirements of White-Egg and Brown-Egg Layers in g/bird/day and in % <sup>1</sup>

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$$\text{Dig. Lys. (g/bird/day)} = 0.1 W^{0.75} + 0.020 G + 0.0115 \text{ Egg}$$

W = Body weight, kg

G = Weight gain, g/ bird/ day

Egg = Egg mass, g egg/bird/day =  $\frac{\% \text{ lay} \times \text{egg weight}}{100}$

Example:

W = 1.6 kg, being:  $W^{0.75} = 1.423$

G = 1 g/ bird/ day

Egg = 50 g/ bird/ day

Dig. Lys. Req. =  $0.1 \times 1.423 + 0.020 \times 10 + 0.0115 \times 50 = 0.737\text{g/day}$

Estimated feed intake = 109.1 g/ bird/ day

Dig. Lys. in Diet =  $\frac{0.737 \times 100}{109.1} = 0.676\%$

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<sup>1</sup> Daily digestible lysine requirement for maintenance =  $0.1 \times (\text{Body weight})^{0.75}$ , was estimated from the values of Fisher, 1998 (Poultry Sci. 77:124) and Edwards et.al., 1999 (Poultry Sci. 78:1412). Digestible lysine requirement for gain was estimated in 0.020 g per g of daily gain, taking into account broiler experiments. The value 0.0115 g. of dig. lysine per g of egg mass was determined using the results of dose-response experiments conducted at UFV, being 5 with white-egg layers (0.0115), 4 with brown-egg layers (0.0113) and 2 with broiler breeder hens (0.0116).

Table 38 - Equation Used to Estimate Metabolizable Energy (ME) Requirements of White-Egg and Brown-Egg Layers in kcal/bird/day

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$$\text{ME (kcal/bird/day)} = 144.5 \cdot W^{0.75} + 3.84 \cdot G + 1.92 \cdot \text{Egg} + 2.0 \cdot W \cdot (21 - T)$$

W = Body weight, kg

G = Weight gain, g/ bird/ day

Egg = g egg/bird/day =  $\frac{\% \text{ lay}}{100} \times \text{Egg weight}$

T = Average temperature, °C

Example:

W = 1.6 kg, being:  $W^{0.75} = 1.423$

G = 10 g/ bird/ day

Egg = 50 g/ bird/ day

T = 21°C

Req. ME =  $144.50 \times 1.423 + 3.84 \times 10 + 1.92 \times 47 + 2.0 \times 1.6 (21 - 21)$

ME =  $205.62 + 3.84 + 96 + 0 = 305.46$  Kcal/ bird/ day

ME diet = 2800 kcal/ kg

Estimated feed intake = 109,1 g/ bird/ day

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Table 39 - Digestible Lysine (Dig. Lys.) Requirement of White-Egg Layers According to Productivity

Age Week	Weight Kg	Wt <sup>0,75</sup>	Gain g/day	Egg Mass g/day	Dig Lys <sup>1</sup> g/day	ME <sup>2</sup> Kcal/day	Intake <sup>3</sup> g/day	Dig Lys %
20	1,378	1,272	4,00	4,4	0,258	199	69	----- <sup>4</sup>
25	1,518	1,368	1,50	48,8	0,727	288	99	0,735
30	1,570	1,403	0,90	54,4	0,784	301	104	0,754
35	1,601	1,423	0,30	55,6	0,787	304	105	0,750
40	1,611	1,430	0,30	55,0	0,781	304	105	0,744
45	1,621	1,437	0,20	54,3	0,772	303	104	0,742
50	1,628	1,441	0,20	54,2	0,771	303	108	0,714
55	1,635	1,446	0,20	52,4	0,752	301	107	0,702
60	1,642	1,451	0,20	50,6	0,731	298	106	0,689
65	1,649	1,455	0,10	48,9	0,710	295	105	0,676
70	1,652	1,457	0,10	47,2	0,691	292	104	0,664
75	1,655	1,459	0,10	45,0	0,666	288	106	0,628
80	1,658	1,461	0,10	42,9	0,641	284	105	0,611

<sup>1</sup> Determined by the equation in Table 37.

<sup>2</sup> Determined by the equation in Table 38 for environmental temperature of 24°C.

<sup>3</sup> The ME levels of 2900, 2800, and 2700 kcal /kg diet were considered for the ages of 20 to 45; 50 to 70, and 75 to 80 weeks , respectively.

<sup>4</sup> Use value of week 25.

Table 40 - Digestible Lysine (Dig. Lys.) Requirement of Brown-Egg Layers According to Productivity

Age Week	Weight Kg	Wt <sup>0.75</sup>	Gain g/day	Egg Mass g/day	Dig Lys <sup>1</sup> g/day	EM <sup>2</sup> Kcal/day	Intake <sup>3</sup> g/day	Dig Lys %
20	1.498	1.354	5.20	12.2	0.380	230	79	----- <sup>4</sup>
25	1.680	1.476	4.30	51.3	0.823	318	110	0.748
30	1.830	1.573	0.50	55.2	0.802	324	112	0.716
35	1.847	1.584	0.30	55.8	0.806	326	112	0.720
40	1.857	1.591	0.20	55.0	0.795	325	112	0.710
45	1.864	1.595	0.20	53.8	0.782	323	112	0.698
50	1.871	1.600	0.20	53.0	0.7773	322	115	0.673
55	1.878	1.604	0.20	52.2	0.765	321	115	0.665
60	1.885	1.609	0.20	51.5	0.758	321	115	0.659
65	1.892	1.613	0.10	49.5	0.731	317	113	0.647
70	1.895	1.615	0.10	47.4	0.708	313	112	0.632
75	1.898	1.617	0.10	44.6	0.676	308	114	0.593
80	1.901	1.619	0.10	41.4	0.640	302	112	0.572

<sup>1</sup> Determined by the equation in Table 37.

<sup>2</sup> Determined by the equation in Table 38 for environmental temperature of 24°C.

<sup>3</sup> The ME levels of 2900, 2800, and 2700 kcal /kg diet were considered for the ages of 20 to 45; 50 to 70, and 75 to 80 weeks , respectively.

<sup>4</sup> Use value of week 25.

Table 41 - Amino Acid / Lysine Ratio Used to Estimate Amino Acid Requirements of White-Egg and Brown-Egg Layers

Amino acid	Digestible	Total
Lysine	100	100
Methionine	50	49
Methionine + Cystine	91	90
Tryptophan	23	23
Threonine	66	68
Arginine	100	96
Glycine + Serine	-	80
Valine	90	90
Isoleucine	83	83
Leucine	122	119
Histidine	29	28
Phenylalanine	65	63
Phenylal. + Tyrosine	118	115



Table 42 - Nutritional Requirements of White-Egg Layers (g/bird/day)

Nutrient		White-Egg Layers				
Crude Protein		16,5				
Calcium		4.02				
Available Phosphorus		0.375				
Potassium		0.580				
Sodium		0.225				
Chloride		0.200				
Linoleic Acid		1.210				
Body Weight, kg	1.470	1.600		1.650		
Weight Gain, g/day	1.5	0.5		0		
Egg Mass, g/day	55	50		45		
Amino Acid <sup>1</sup>	Dig.	Total	Dig.	Total	Dig.	Total
Lysine	0.796	0.894	0.727	0.817	0.663	0.745
Methionine	0.398	0.438	0.364	0.400	0.332	0.365
Methionine + Cystine	0.724	0.805	0.662	0.735	0.603	0.671
Tryptophan	0.183	0.206	0.167	0.188	0.152	0.171
Threonine	0.525	0.608	0.480	0.556	0.438	0.507
Arginine	0.796	0.858	0.727	0.784	0.663	0.715
Glycine + Serine	-	0.715	-	0.654	-	0.596
Valine	0.716	0.805	0.654	0.735	0.597	0.671
Isoleucine	0.661	0.742	0.603	0.678	0.550	0.618
Leucine	0.971	1.064	0.887	0.972	0.809	0.887
Histidine	0.231	0.250	0.211	0.229	0.192	0.209
Phenylalanine	0.517	0.563	0.473	0.515	0.431	0.469
Phenylal.+Tyrosine	0.939	1.028	0.858	0.940	0.782	0.857

<sup>1</sup> Amino acid requirements were determined using Table 37 (Dig. Lysine equation) and Table 41 (Amino acid / lysine ratio). Total lysine requirement was calculated considering the average true lysine digestibility of 89%.

Table 43 - Nutritional Requirements of Brown-Egg Layers (g/bird/day)

Nutrient		Brown-Egg Layers					
Crude Protein		17.0					
Calcium		4.2					
Available Phosphorus		0.375					
Potassium		0.590					
Sodium		0.230					
Chloride		0.210					
Linoleic Acid		1.210					
Body Weight, kg		1.600	1.800	1.900			
Weight Gain, g/day		2.00	1.00	0			
Egg Mass, g/day		55	50	45			
Amino Acid <sup>1</sup>	Dig.	Total	Dig.	Total	Dig.	Total	
Lysine	0.815	0.916	0.750	0.843	0.679	0.763	
Methionine	0.408	0.449	0.375	0.413	0.340	0.374	
Methionine + Cystine	0.742	0.824	0.683	0.759	0.618	0.687	
Tryptophan	0.187	0.211	0.173	0.194	0.156	0.175	
Threonine	0.538	0.623	0.495	0.573	0.448	0.519	
Arginine	0.815	0.879	0.750	0.809	0.679	0.732	
Glycine + Serine	-	0.733	-	0.674	-	0.610	
Valine	0.734	0.894	0.675	0.759	0.611	0.687	
Isoleucine	0.676	0.760	0.623	0.700	0.564	0.633	
Leucine	0.994	1.090	0.915	1.003	0.828	0.908	
Histidine	0.236	0.256	0.218	0.236	0.197	0.214	
Phenylalanine	0.530	0.577	0.488	0.531	0.441	0.481	
Phenylal.+Tyrosine	0.962	1.053	0.885	0.969	0.801	0.877	

<sup>1</sup> Amino acid requirements were determined using Table 37 (Dig. Lysine equation) and Table 41 (Amino acid / lysine ratio). Total lysine requirement was calculated considering the average true lysine digestibility of 89%.

Table 44 - Energy Requirement (kcal ME /bird/day) and Feed Intake (g/bird/day) of White-Egg and Brown-Egg Layers <sup>1,2</sup>

Body Weight (kg)	1.400			1.600			1.800		
Weight Gain (g/bird/day)	2			1			0		
Egg Mass (g/bird/day)	55	50	45	55	50	45	55	50	45
Average Temperature									
16 °C	313.3 <sup>1</sup>	303.7	294.1	331.1	321.5	311.9	348.2	338.6	329
	(111.9) <sup>2</sup>	(108.5)	(105.0)	(118.3)	(114.8)	(111.4)	(124.4)	(120.9)	(117.5)
21 °C	299.3	289.7	280.1	315.1	305.5	295.9	330.2	320.6	311.0
	(106.9)	(103.4)	(100.0)	(112.5)	(109.1)	(105.7)	(117.9)	(114.5)	(111.1)
26 °C	285.3	275.7	266.1	299.1	289.5	279.9	312.2	302.6	293.0
	(101.9)	(98.5)	(95.0)	(106.8)	(103.4)	(100.0)	(111.5)	(108.1)	(104.6)

<sup>1</sup> Energy requirement was determined by the equation in Table 38.

<sup>2</sup> Feed intake was determined by dividing requirement of ME/ bird/ day by dietary ME content. It was assumed a dietary level of 2800 kcal of ME / kg.

Table 45 - Nutritional Requirements (%) of White-Egg Layers According to Productivity, Metabolizable Energy and Feed Intake

Body Weight, kg		1.470		1.600		1.650	
Weight Gain, g/day		1.5		0.5		0	
Egg Mass, g/day		55		50		45	
ME Requirement, kcal/day <sup>1</sup>		304		303		297	
ME Diet, kcal/kg		2900		2800		2700	
Feed Intake, g/ day <sup>2</sup>		105		108		110	
Crude Protein <sup>3</sup>	%	15.71		15.28		15.0	
Calcium	%	3.83		3.72		3.66	
Available Phosphorus	%	0.357		0.347		0.341	
Potassium	%	0.552		0.537		0.527	
Sodium	%	0.214		0.208		0.205	
Chloride	%	0.191		0.185		0.182	
Linoleic Acid	%	1.152		1.120		1.100	
Amino Acid		Dig.	Total	Dig.	Total	Dig.	Total
Lysine <sup>3</sup>	%	0.758	0.851	0.673	0.756	0.603	0.677
Methionine	%	0.379	0.417	0.337	0.370	0.302	0.332
Methionine + Cystine	%	0.690	0.766	0.612	0.680	0.549	0.609
Tryptophan	%	0.174	0.196	0.155	0.174	0.139	0.156
Threonine	%	0.500	0.579	0.444	0.514	0.398	0.460
Arginine	%	0.758	0.817	0.673	0.726	0.603	0.650
Glycine + Serine	%	-	0.681	-	0.605	-	0.542
Valine	%	0.682	0.766	0.606	0.680	0.543	0.609
Isoleucine	%	0.629	0.706	0.559	0.627	0.500	0.562
Leucine	%	0.925	1.013	0.821	0.900	0.736	0.806
Histidine	%	0.220	0.238	0.195	0.212	0.175	0.190
Phenylalanine	%	0.493	0.536	0.437	0.476	0.392	0.427
Phenylalanine + Tyrosine	%	0.894	0.979	0.794	0.869	0.712	0.779

<sup>1</sup> Determined by the equation in Table 38 for an environmental temperature of 21°C.

<sup>2</sup> Determined by dividing daily ME requirement by dietary energy content..

<sup>3</sup> Nutrient percentage is determined using the requirement in g/ bird/ day (Table 42) and feed intake in g/ bird/ day.

Table 46 - Nutritional Requirements (%) of White-Egg Layers According to Productivity, Metabolizable Energy and Feed Intake, Under Different Temperatures

Body Weight, kg		1.470		1.600		
Weight Gain, g/day		1.5		0.5		
Egg Mass, g/day		55		50		
ME Requirement, kcal/day <sup>1</sup>	276	299	319	266	288	308
Feed Intake, g/day <sup>2</sup>	95	103	110	95	103	110
Crude Protein <sup>3</sup>	%	17.37	16.02	15.00	17.37	16.02
Calcium	%	4.23	3.90	3.66	4.23	3.90
Available Phosphorus	%	0.395	0.364	0.341	0.395	0.364
Potassium <sup>4</sup>	%	0.611	0.563	0.527	0.611	0.563
Sodium	%	0.237	0.218	0.205	0.237	0.218
Chloride	%	0.211	0.194	0.181	0.211	0.194
Linoleic Acid	%	1.274	1.175	1.100	1.274	1.100
Digestible Amino Acid						
Lysine <sup>3</sup>	%	0.838	0.773	0.724	0.765	0.661
Methionine	%	0.419	0.387	0.362	0.383	0.331
Methionine + Cystine	%	0.763	0.703	0.659	0.696	0.602
Tryptophan	%	0.193	0.178	0.166	0.176	0.152
Threonine	%	0.553	0.510	0.478	0.505	0.436
Arginine	%	0.838	0.773	0.724	0.765	0.661
Valine	%	0.754	0.696	0.652	0.688	0.595
Isoleucine	%	0.696	0.642	0.601	0.635	0.549
Leucine	%	1.022	0.943	0.883	0.933	0.806
Histidine	%	0.243	0.224	0.210	0.222	0.192
Phenylalanine	%	0.545	0.502	0.471	0.497	0.430
Phenylal. + Tyrosine	%	0.989	0.912	0.854	0.903	0.780
Total Amino Acid						
Lysine	%	0.941	0.868	0.813	0.86	0.793
Methionine	%	0.461	0.425	0.398	0.421	0.389
Methionine + Cystine	%	0.847	0.781	0.732	0.774	0.669
Tryptophan	%	0.216	0.200	0.187	0.198	0.171
Threonine	%	0.640	0.590	0.553	0.585	0.505
Arginine	%	0.903	0.833	0.780	0.826	0.713
Glycine + Serine	%	0.753	0.694	0.650	0.688	0.594
Valine	%	0.847	0.781	0.732	0.774	0.669
Isoleucine	%	0.781	0.720	0.675	0.714	0.617
Leucine	%	1.120	1.033	0.967	1.023	0.884
Histidine	%	0.263	0.243	0.228	0.241	0.208
Phenylalanine	%	0.593	0.547	0.512	0.542	0.468
Phenylal. + Tyrosine	%	1.082	0.998	0.935	0.989	0.854

<sup>1</sup> Determined by the equation in Table 38 for layers under different environmental temperatures.

<sup>2</sup> Determined by dividing daily ME requirement by dietary energy content. It was assumed a ME level of 2900 and 2800 kcal / kg, respectively.

<sup>3</sup> Nutrient percentage is determined using the requirement in g/ bird/ day (Table 42) and feed intake in g/ bird/ day.

Table 47 - Nutritional Requirements (%) of Brown-Egg Layers According to Productivity, Metabolizable Energy and Feed Intake

Body Weight, kg		1.600		1.800		1.900	
Weight Gain, g/day		2		1		0	
Egg Mass, g/day		55		50		45	
ME Requirement, kcal/day <sup>1</sup>		319		323		320	
ME Diet, kcal/kg		2900		2800		2700	
Feed Intake, g/ day <sup>2</sup>		110		115		118	
Crude Protein <sup>3</sup>	%	15.45		14.78		14.41	
Calcium	%	3.82		3.65		3.56	
Available Phosphorus	%	0.341		0.326		0.318	
Potassium	%	0.536		0.513		0.500	
Sodium	%	0.209		0.200		0.195	
Chloride	%	0.191		0.183		0.178	
Linoleic Acid	%	1.100		1.052		1.026	
Amino Acid		Dig.	Total	Dig.	Total	Dig.	Total
Lysine <sup>3</sup>	%	0.741	0.833	0.652	0.733	0.590	0.647
Methionine	%	0.371	0.408	0.326	0.359	0.295	0.317
Methionine + Cystine	%	0.674	0.750	0.593	0.660	0.537	0.582
Tryptophan	%	0.170	0.192	0.150	0.168	0.134	0.149
Threonine	%	0.489	0.566	0.430	0.498	0.389	0.440
Arginine	%	0.741	0.800	0.652	0.704	0.590	0.621
Glycine + Serine	%	-	0.666	-	0.586	-	0.518
Valine	%	0.667	0.750	0.587	0.660	0.531	0.582
Isoleucine	%	0.615	0.691	0.541	0.608	0.490	0.537
Leucine	%	0.904	0.991	0.795	0.872	0.720	0.770
Histidine	%	0.215	0.233	0.189	0.205	0.171	0.181
Phenylalanine	%	0.482	0.525	0.424	0.462	0.384	0.408
Phenylal. + Tyrosine	%	0.874	0.958	0.769	0.843	0.696	0.744

<sup>1</sup> Determined by the equation in Table 38 for an environmental temperature of 21°C.

<sup>2</sup> Determined by dividing daily ME requirement by dietary energy content..

<sup>3</sup> Nutrient percentage is determined using the requirement in g/ bird/ day (Table 43) and feed intake in g/ bird/ day.

Table 48 - Nutritional Requirements (%) of Brown-Egg Layers According to Productivity, Metabolizable Energy and Feed Intake, Under Different Temperatures.

Body Weight, kg		1.600			1.800	
Weight Gain, g/day		2.00			1.00	
Egg Mass, g/day		55			50	
ME Requirement, kcal/day <sup>1</sup>		290	310	334	280	300
Feed Intake, g/day <sup>2</sup>		100	107	115	100	107
Crude Protein <sup>3</sup>	%	17.00	15.89	14.78	17.00	15.89
Calcium	%	4.20	3.93	3.65	4.20	3.93
Available Phosphorus	%	0.375	0.350	0.326	0.375	0.350
Potassium <sup>4</sup>	%	0.590	0.551	0.513	0.590	0.551
Sodium	%	0.230	0.215	0.200	0.230	0.215
Chloride	%	0.210	0.196	0.183	0.210	0.196
Linoleic Acid	%	1.210	0.131	1.052	1.210	1.131
Digestible Amino Acid						
Lysine <sup>3</sup>	%	0.815	0.762	0.709	0.750	0.701
Methionine	%	0.408	0.381	0.355	0.375	0.351
Methionine + Cystine	%	0.742	0.693	0.645	0.683	0.638
Tryptophan	%	0.187	0.175	0.163	0.173	0.161
Threonine	%	0.538	0.503	0.468	0.495	0.463
Arginine	%	0.815	0.762	0.709	0.750	0.701
Valine	%	0.733	0.686	0.638	0.675	0.631
Isoleucine	%	0.676	0.632	0.588	0.623	0.582
Leucine	%	0.994	0.930	0.865	0.915	0.855
Histidine	%	0.236	0.221	0.206	0.218	0.203
Phenylalanine	%	0.530	0.495	0.461	0.488	0.456
Phenylalanine + Tyrosine	%	0.962	0.899	0.837	0.885	0.827
Total Amino Acid						
Lysine	%	0.916	0.856	0.797	0.843	0.788
Methionine	%	0.449	0.419	0.391	0.413	0.386
Methionine + Cystine	%	0.824	0.770	0.717	0.759	0.709
Tryptophan	%	0.211	0.197	0.183	0.194	0.181
Threonine	%	0.623	0.582	0.542	0.573	0.536
Arginine	%	0.879	0.822	0.765	0.809	0.756
Glycine + Serine	%	0.733	0.685	0.638	0.674	0.630
Valine	%	0.824	0.770	0.717	0.759	0.709
Isoleucine	%	0.760	0.710	0.662	0.700	0.654
Leucine	%	1.090	1.019	0.948	1.003	0.938
Histidine	%	0.256	0.240	0.223	0.236	0.221
Phenylalanine	%	0.577	0.539	0.502	0.531	0.496
Phenylalanine + Tyrosine	%	1.053	0.984	0.917	0.969	0.906

<sup>1</sup> Determined by the equation in Table 38 for layers under different environmental temperatures.

<sup>2</sup> Determined by dividing daily ME requirement by dietary energy content. It was assumed a ME level of 2900 and 2800 kcal / kg, respectively.

<sup>3</sup> Nutrient percentage is determined using the requirement in g/ bird/ day (Table 43) and feed intake in g/ bird/ day.





## **Nutritional Requirements of Broiler Breeders**



Table 49 - Amino Acid / Lysine Ratio Used to Estimate Amino Acid Requirements of Replacement Broiler Breeder Pullets

Phase	Starter		Grower		Developer	
Age (weeks)	1- 6		7 - 12		13 - 18	
Amino Acid	Digestible	Total	Digestible	Total	Digestible	Total
Lysine	100	100	100	100	100	100
Methionine	40	40	43	44	45	45
Methionine + Cystine	73	73	79	80	82	83
Tryptophan	18	18	20	20	22	22
Threonine	67	70	68	71	69	72
Arginine	107	105	108	106	110	107
Glycine + Serine	-	140	-	135	-	130
Valine	76	78	80	81	82	83
Isoleucine	69	70	75	76	77	78
Leucine	112	111	118	117	125	124
Histidine	37	37	38	38	39	39
Phenylalanine	66	66	69	69	72	72
Phenylal. + Tyrosine	121	120	125	125	130	130

Table 50 - Nutritional Requirements of Broiler Breeder Pullets  
(% per 1000 kcal ME diet)<sup>1</sup>

Phase		Starter		Grower		Developer	
Age (weeks)		1 - 6		7 - 12		13 - 18	
Crude Protein	%	6.39		5.71		5.00	
Calcium	%	0.326		0.319		0.304	
Available Phosphorus	%	0.151		0.149		0.121	
Potassium	%	0.178		0.182		0.175	
Sodium	%	0.060		0.059		0.057	
Chloride	%	0.054		0.054		0.054	
Linoleic Acid	%	0.362		0.376		0.361	
Amino Acid		Dig.	Total	Dig.	Total	Dig.	Total
Lysine	%	0.311	0.345	0.219	0.243	0.204	0.227
Methionine	%	0.125	0.138	0.096	0.107	0.092	0.102
Methionine + Cystine	%	0.227	0.252	0.174	0.194	0.167	0.188
Tryptophan	%	0.056	0.062	0.044	0.049	0.045	0.050
Threonine	%	0.208	0.242	0.149	0.173	0.141	0.163
Arginine	%	0.333	0.362	0.236	0.258	0.224	0.243
Glycine + Serine	%	-	0.483	-	0.328	-	0.295
Valine	%	0.236	0.269	0.175	0.197	0.167	0.188
Isoleucine	%	0.214	0.242	0.164	0.185	0.157	0.177
Leucine	%	0.348	0.383	0.258	0.284	0.255	0.281
Histidine	%	0.115	0.128	0.083	0.092	0.080	0.088
Phenylalanine	%	0.205	0.228	0.151	0.168	0.147	0.163
Phenylal. + Tyrosine	%	0.376	0.414	0.274	0.304	0.265	0.295

<sup>1</sup> To determine nutrient percentage in the diet, multiply the requirements in the table above by the dietary ME in Mcal; Ex.: Dig. Lysine for birds in the starter phase, diet containing 2.975 Mcal / kg x 0.311 = 0.925 %. Total lysine requirement was calculated considering the average true lysine digestibility of 90%.

Table 51 - Nutritional Requirements of Broiler Breeder Pullets According to Dietary Energy Level<sup>1</sup>

Phases		Starter		Grower		Developer	
Age (weeks)		1 - 6		7 - 12		13 - 18	
Met. Energy kcal/kg		2,975		2,800		2,800	
Crude Protein	%	19		16		14	
Calcium	%	0.970		0.894		0.850	
Available Phosphorus	%	0.450		0.416		0.340	
Potassium	%	0.530		0.510		0.490	
Sodium	%	0.180		0.166		0.160	
Chloride	%	0.160		0.150		0.150	
Linoleic Acid	%	1.078		1.053		1.010	
Amino Acid		Dig.	Total	Dig.	Total	Dig.	Total
Lysine	%	0.925	1.027	0.613	0.680	0.571	0.636
Methionine	%	0.371	0.411	0.268	0.300	0.257	0.286
Methionine + Cystine	%	0.675	0.750	0.488	0.543	0.468	0.526
Tryptophan	%	0.166	0.185	0.123	0.137	0.126	0.140
Threonine	%	0.620	0.719	0.417	0.484	0.394	0.456
Arginine	%	0.990	1.078	0.662	0.722	0.628	0.680
Glycine + Serine	%	-	1.438	-	0.918	-	0.826
Valine	%	0.703	0.801	0.490	0.552	0.468	0.526
Isoleucine	%	0.638	0.719	0.460	0.518	0.440	0.496
Leucine	%	1.036	1.140	0.723	0.795	0.714	0.787
Histidine	%	0.342	0.380	0.233	0.258	0.223	0.246
Phenylalanine	%	0.611	0.678	0.423	0.470	0.411	0.456
Phenylal. + Tyrosine	%	1.119	1.232	0.766	0.851	0.742	0.826

<sup>1</sup> To determine nutrient percentage in the diet, multiply the requirements in table 50 by the dietary ME in Mcal; Ex.: Dig. Lysine for birds in the starter phase, diet containing 2.975 Mcal / kg x 0.311 = 0.925%.

Table 52 - Equation Used to Estimate True Digestible Lysine Requirement of of Broiler Breeder Hens in g/bird/day and in %<sup>1</sup>

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$$\text{Dig. Lys. (g/bird/day)} = 0.1 W^{0.75} + 0.020 G + 0.0115 \text{ Egg}$$

W = Body weight, kg

G = Weight gain, g/ bird/ day

Egg = Egg mass, g egg/bird/day =  $\frac{\% \text{ lay} \times \text{egg weight}}{100}$

Exemplo:

W = 3.0 kg, being:  $W^{0.75} = 2.279$

G = 10 g/ bird/ day

Egg = 47g/ bird/ day

Dig. Lys. Req. =  $0.1 \times 2.279 + 0.020 \times 10 + 0.0115 \times 47 = 0.968$  g/day

Estimated feed intake = 168.7 g/ bird/ day

Dig. Lys. in feed =  $\frac{0.968 \times 100}{168.7} = 0.574\%$

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<sup>1</sup> Daily digestible lysine requirement for maintenance =  $0.1 \times (\text{Body Weight})^{0.75}$ , was estimated from the values of Fisher, 1998 (Poultry Sci. 77:124) and Edwards et.al., 1999 (Poultry Sci. 78:1412). Digestible lysine requirement for gain was estimated in 0.020 g per g of daily gain, taking into account broiler experiments. The value 0.0115 g. of dig. lysine per g of egg mass was determined using the results of dose-response experiments conducted at UFV, being 5 with white-egg layers (0.0115), 4 with brown-egg layers (0.0113) and 2 with broiler breeder hens (0.0116).

Table 53 - Equation Used to Estimate Metabolizable Energy (ME) Requirements of Broiler Breeder Hens in kcal/bird/day

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$$\text{ME (kcal/bird/day)} = 144.50 \cdot W^{0.75} + 3.84 \cdot G + 1.92 \cdot \text{Egg} + 2.0 \cdot W \cdot (21-T)$$

W = Body weight, kg

G = Weight gain, g/ bird/ day

Egg = g egg/bird/day =  $\frac{\% \text{ lay}}{100} \times \text{Egg weight}$

T = Average temperature, °C

Example:

W = 3.0 kg, being:  $W^{0.75} = 2.279$

G = 10 g/ bird/ day

Egg = 47g/ bird/ day

T = 21°C

Req. ME =  $144.50 \times 2.279 + 3.84 \times 10 + 1.92 \times 47 + 2.0 \times 3.0 (21 - 21)$

ME =  $329.31 + 38.4 + 90.24 + 6.0 + 0 = 464 \text{ kcal/ bird/ day}$

ME fed = 2750 kcal/ kg

Estimated feed intake =  $168.7 \text{ g/ bird/ day}$

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Table 54 - Digestible Lysine (Dig. Lys.) Requirements of Broiler Breeder Hens According to Productivity

Age Week	Weight kg	Wt <sup>0,75</sup>	Gain g/day	Egg Mass g/day	Dig. Lys.. <sup>1</sup> g/day	EM <sup>2</sup> kcal/day	Intake <sup>3</sup> g/day	Dig Lys %
25	3,000	2,280	10,0	5,0	0,485	359	131	----- <sup>4</sup>
30	3,350	2,476	3,0	47,6	0,855	441	160	0,534
35	3,455	2,534	3,0	50,2	0,891	453	165	0,540
40	3,560	2,592	2,0	48,8	0,860	455	165	0,521
45	3,630	2,630	2,0	46,2	0,834	455	165	0,506
50	3,720	2,679	2,0	43,6	0,809	456	166	0,487
55	3,790	2,716	2,0	40,8	0,781	456	166	0,470
60	3,860	2,754	1,0	38,0	0,732	452	164	0,446
65	3,895	2,773	1,0	34,8	0,697	448	163	0,428

<sup>1</sup> Determined by the equation in Table 52.

<sup>2</sup> Determined by the equation in Table 53 for environmental temperature of 24°C.

<sup>3</sup> The ME levels of 2750 kcal /kg diet was considered for all ages.

<sup>4</sup> Use value of week 30.



Table 55 - Amino Acid / Lysine Ratio Used to Estimate Amino Acid Requirements of Broiler Breeders

Amino Acid	Breeder Hens		Cockerels	
	Digestible	Total	Digestible	Total
Lysine	100	100	100	100
Methionine	48	47	58	57
Methionine + Cystine	87	86	105	103
Tryptophan	23	23	29	29
Threonine	81	84	97	101
Arginine	115	109	140	133
Glycine + Serine	-	106	-	150
Valine	90	90	127	127
Isoleucine	90	89	109	108
Leucine	135	132	155	150
Histidine	35	34	31	30
Phenylalanine	73	72	82	81
Phenylal. + Tyrosine	132	130	153	150

Table 56 - Nutritional Requirements of Broiler Breeder Hens (g/bird/day)

Nutrient		Broiler Breeder Hens				
Crude Protein		21				
Calcium		4.10				
Available Phosphorus		0.400				
Potassium		1.000				
Sodium		0.250				
Chloride		0.220				
Linoleic Acid		2.000				
Body Weight, kg	2.900	3.300		3.600		
Weight Gain, g/day	6.0	2.0		0.0		
Egg Mass, g/day	50	44		40		
Amino Acid <sup>1</sup>	Dig.	Total	Dig.	Total	Dig.	Total
Lysine	0.917	1.030	0.791	0.889	0.721	0.810
Methionine	0.440	0.484	0.380	0.418	0.346	0.381
Methionine + Cystine	0.798	0.886	0.688	0.765	0.627	0.697
Tryptophan	0.211	0.237	0.182	0.204	0.166	0.186
Threonine	0.743	0.865	0.641	0.747	0.584	0.680
Arginine	1.055	1.123	0.910	0.969	0.829	0.883
Glycine + Serine	-	1.092	-	0.942	-	0.859
Valine	0.825	0.927	0.712	0.800	0.649	0.729
Isoleucine	0.825	0.917	0.712	0.791	0.649	0.721
Leucine	1.238	1.360	1.068	1.173	0.973	1.069
Histidine	0.321	0.350	0.277	0.302	0.252	0.275
Phenylalanine	0.669	0.742	0.577	0.640	0.526	0.583
Phenylal.+Tyrosine	1.210	1.339	1.044	1.156	0.952	1.053

<sup>1</sup> Amino acid requirements were determined using Table 52 (Dig. Lysine equation) and Table 55 (Amino acid / lysine ratio). Total lysine requirement was calculated considering the average true lysine digestibility of 89%.

Table 57 - Energy Requirements (kcal ME/bird/day) and Feed Intake (g/bird/day) of Broiler Breeder Hens <sup>1,2</sup>

Body Weight (kg)	2.800			3.300			3.600		
Weight Gain (g/bird/day)	6			2			0		
Egg Mass (g/bird/day)	50	44	40	50	44	40	50	44	40
Average Temperature									
16°C	469.1 <sup>1</sup>	457.6	449.9	490.4	478.9	471.2	509.7	498.2	490.0
	(170.6) <sup>2</sup>	(166.4)	(163.6)	(178.3)	(174.1)	(171.3)	(185.3)	(181.2)	(178.2)
21°C	440.1	428.6	420.9	457.4	445.9	438.2	473.7	462.2	454.0
	(160.0)	(155.9)	(153.1)	(166.3)	(162.1)	(159.4)	(172.3)	(168.1)	(165.0)
26°C	411.1	399.6	391.9	424.4	412.9	405.2	437.7	426.2	418.0
	(149.5)	(145.3)	(142.5)	(154.3)	(150.1)	(147.3)	(159.2)	(155.0)	(152.0)

<sup>1</sup> Energy requirement was determined by the equation in Table 53.

<sup>2</sup> Feed intake was determined by dividing requirement of ME/ bird/ day by dietary ME content. It was assumed a dietary level of 2750 kcal of ME / kg.

**Table 58 - Nutritional Requirements (%) of Broiler Breeder Hens According to Productivity, Metabolizable Energy and Feed Intake**

Body Weight, kg		2.900		3.300		3.600	
Weight Gain, g/day		6.0		2.0		0.0	
Egg Mass, g/day		50		44		40	
ME Requirement, kcal/day <sup>1</sup>		440		446		454	
ME Diet, kcal/kg		2750		2750		2750	
Feed Intake, g/ day <sup>2</sup>		160		162		165	
Crude Protein <sup>3</sup>	%	13.13		12.96		12.73	
Calcium	%	2.56		2.53		2.48	
Available Phosphorus	%	0.250		0.247		0.242	
Potassium	%	0.625		0.617		0.606	
Sodium	%	0.156		0.154		0.152	
Chloride	%	0.138		0.136		0.133	
Linoleic Acid	%	1.250		1.235		1.212	
Amino Acid		Dig.	Total	Dig.	Total	Dig.	Total
Lysine <sup>3</sup>	%	0.573	0.644	0.488	0.549	0.437	0.491
Methionine	%	0.275	0.303	0.234	0.258	0.210	0.231
Methionine + Cystine	%	0.499	0.554	0.425	0.472	0.380	0.422
Tryptophan	%	0.132	0.148	0.112	0.126	0.101	0.113
Threonine	%	0.464	0.541	0.395	0.461	0.354	0.412
Arginine	%	0.659	0.702	0.561	0.598	0.503	0.535
Glycine + Serine	%	-	0.683	-	0.582	-	0.520
Valine	%	0.516	0.588	0.439	0.494	0.393	0.442
Isoleucine	%	0.516	0.573	0.439	0.489	0.393	0.437
Leucine	%	0.774	0.850	0.659	0.725	0.590	0.648
Histidine	%	0.201	0.219	0.171	0.187	0.153	0.167
Phenylalanine	%	0.418	0.464	0.356	0.395	0.319	0.354
Phenylal. + Tyrosine	%	0.756	0.837	0.644	0.714	0.577	0.638

<sup>1</sup> Determined by the equation in Table 53 for an environmental temperature of 21°C.

<sup>2</sup> Determined by dividing daily ME requirement by dietary energy content.. It was assumed a dietary level of 2750 kcal of ME / kg.

<sup>3</sup> Nutrient percentage is determined using the requirement in g/ bird/ day (Table 56) and feed intake in g/ bird/ day.

Table 59 - Nutritional Requirements (%) of Broiler Breeder Hens According to Productivity, Metabolizable Energy and Feed Intake, Under Different Temperatures

Body Weight, kg		2.900		3.300		
Weight Gain, g/day		6.0		2.0		
Egg Mass, g/day		50		44		
ME Requirement, kcal/day <sup>1</sup>		413	440	468	413	440
Feed Intake, g/day <sup>2</sup>		150	160	170	150	160
Crude Protein <sup>3</sup>	%	14.00	13.13	12.35	14.00	13.13
Calcium	%	2.73	2.56	2.41	2.73	2.56
Available Phosphorus	%	0.267	0.250	0.235	0.267	0.250
Potassium <sup>4</sup>	%	0.667	0.625	0.588	0.667	0.625
Sodium	%	0.167	0.156	0.147	0.167	0.156
Chloride	%	0.147	0.130	0.129	0.157	0.130
Linoleic Acid	%	1.333	1.250	1.176	1.333	1.250
Digestible Amino Acid						
Lysine <sup>3</sup>	%	0.611	0.573	0.539	0.527	0.494
Methionine	%	0.293	0.275	0.259	0.253	0.237
Methionine + Cystine	%	0.532	0.499	0.469	0.458	0.430
Tryptophan	%	0.141	0.132	0.124	0.121	0.114
Threonine	%	0.495	0.464	0.437	0.427	0.400
Arginine	%	0.703	0.659	0.620	0.606	0.568
Valine	%	0.550	0.516	0.485	0.474	0.445
Isoleucine	%	0.550	0.516	0.485	0.474	0.445
Leucine	%	0.825	0.774	0.728	0.711	0.667
Histidine	%	0.214	0.201	0.189	0.184	0.173
Phenylalanine	%	0.446	0.418	0.393	0.385	0.361
Phenylalanine + Tyrosine	%	0.807	0.756	0.711	0.696	0.652
Total Amino Acid						
Lysine	%	0.687	0.644	0.606	0.593	0.556
Methionine	%	0.323	0.303	0.285	0.279	0.261
Methionine + Cystine	%	0.591	0.554	0.521	0.510	0.478
Tryptophan	%	0.158	0.148	0.139	0.136	0.128
Threonine	%	0.577	0.541	0.509	0.498	0.467
Arginine	%	0.749	0.702	0.661	0.646	0.606
Glycine + Serine	%	0.728	0.683	0.642	0.629	0.589
Valine	%	0.618	0.580	0.545	0.537	0.500
Isoleucine	%	0.611	0.573	0.539	0.528	0.495
Leucine	%	0.907	0.850	0.800	0.783	0.734
Histidine	%	0.234	0.219	0.206	0.202	0.189
Phenylalanine	%	0.495	0.464	0.436	0.427	0.400
Phenylalanine + Tyrosine	%	0.893	0.837	0.788	0.771	0.723

<sup>1</sup> Determined by the equation in Table 53 for hens under different environmental temperatures.

<sup>2</sup> Determined by dividing daily ME requirement by dietary energy content. It was assumed a ME level of 2750 kcal / kg.

<sup>3</sup> Nutrient percentage is determined using the requirement in g/ bird/ day (Table 56) and feed intake in g/ bird/ day.

Table 60 - Nutritional Requirements of Broiler Cockerels According to Metabolizable Energy and Feed Intake (g/day ou %) <sup>1, 2</sup>

ME Requirement, kcal/day	-	360	385
Feed Intake, g/day <sup>1</sup>	-	130	140
Nutrient	g/day	%	%
Crude Protein <sup>2</sup>	16.40	12.61	11.71
Calcium	0.650	0.500	0.464
Available Phosphorus	0.300	0.231	0.214
Potassium	0.750	0.577	0.536
Sodium	0.230	0.177	0.164
Chloride	0.187	0.144	0.134
Linoleic Acid	1.300	1.000	0.929
Amino Acid	Dig. g/day	Total g/day	Dig. % Total % Dig. % Total %
Lysine <sup>2</sup>	0.464	0.525	0.357 0.404 0.331 0.375
Methionine	0.268	0.298	0.206 0.229 0.191 0.213
Methionine + Cystine	0.488	0.542	0.375 0.417 0.349 0.387
Tryptophan	0.135	0.153	0.104 0.118 0.096 0.109
Threonine	0.449	0.528	0.345 0.406 0.321 0.377
Arginine	0.651	0.700	0.501 0.538 0.465 0.500
Glycine + Serine	-	0.789	- 0.789 - 0.850
Valine	0.588	0.666	0.452 0.512 0.420 0.476
Isoleucine	0.505	0.565	0.388 0.435 0.361 0.404
Leucine	0.719	0.790	0.553 0.608 0.514 0.564
Histidine	0.146	0.160	0.112 0.123 0.104 0.114
Phenylalanine	0.387	0.425	0.298 0.327 0.276 0.304
Phenylalanine + Tyrosine	0.719	0.790	0.553 0.608 0.514 0.564

<sup>1</sup> Determined by dividing daily ME requirement by dietary energy content. It was assumed a ME level of 2750 kcal / kg.

<sup>2</sup> Nutrient percentage is determined by using the requirement in g/ bird/ day in the Table above, also Table 55 (Amino acid / Lysine ratio) and feed intake in g/bird/day. Total lysine requirement was calculated considering the average true lysine digestibility of 88.4%.

## **CHAPTER 3**

### **Nutritional Requirements of Swine**





## INTRODUCTION

In order to understand the following tables, some issues must be considered:

- \* Swine nutritional requirements depend on several factors, such as breed, genetic strain, sex, heterosis, development stage, feed intake, dietary energy level, nutrient availability, environmental temperature, air humidity, health status, etc.
- \* Swine nutritional requirements were determined in a series of dose-response trials carried out at the Universidade Federal de Viçosa (UFV), associated to the observation of commercial herds in several Brazilian regions.
- \* Basal reference diets used in the experiments were formulated on corn and soybean meal. Therefore, when other ingredients are used, corrections as to nutrients digestibility or availability need to be made. This is the reason why requirements are expressed on true digestible amino acids.
- \* Only the main nutrients are mentioned. The others are assumed as adequately supplied provided they are offered in equivalent amount to the vitamin and mineral supplements included in this publication.
- \* All nutritional recommendations are for herds with high genetic potential. In order to aid the formulation of diets for high genetic potential pigs with different performances, nutritional recommendations for below average, standard and high productive indexes are included.
- \* When growing swine are fed "*ad libitum*", feed intake and particularly feed conversion depend on the energy level. Therefore, nutritional requirements of crude protein, calcium, phosphorus, potassium, sodium, chloride, and linoleic acid, were established according to dietary metabolizable energy (ME) level and are expressed as as percentage per 1000 kcal ME.

- \* Examples of nutritional requirements for swine rations with energy levels normally used in Brazil were included. For other energy levels, just use the percentage of nutrient per 1000 kcal ME ratio.
- \* High calcium and phosphorus levels must be avoided in swine diets, as they may impair animal performance, in addition to contributing to environmental pollution. Ca : total P ratio must be kept around 1.2:1 in the recommended levels. There are few experimental data on sodium, potassium, and chloride requirements, but it was decided to include recommendations for these nutrients to provide adequate dietary electrolytic (cation-anion) balance.
- \* It would be virtually impossible to establish one single energy level for each type of swine ration. Dietary energy level varies according to the economic results to be obtained, that is, with the prices of the ingredients and of the pork products. For instance, if vegetable oil or animal fat can be obtained at reasonable prices, higher energy levels can be used in the diets. On the other hand, low energy feedstuffs available at low prices induce to lower dietary energy levels.
- \* The main concern should not be to formulate only least cost rations. It is more important to formulate a feed that allows the least production cost, that is, a diet that promotes the best possible performance at the lowest possible cost.
- \* The established protein levels should be assumed only as practical suggestions. These are minimum values for diets based on corn and soybean meal when the synthetic amino acids lysine, methionine, and threonine are offered. Excellent experimental and practical results have been obtained with lower protein rations by maintaining the recommended levels of essential amino acids, which are indeed the most important. The main objective is to

reduce the impact on the environment of the excess of nutrients in swine diets,

- \* In general, at the recommended protein levels, arginine, valine, isoleucine, leucine, histidine, and phenylalanine +tyrosine requirements are met.
- \* Amino acids levels must be close to the recommendations. High protein diets must also be avoided.
- \* Digestible methionine + cystine requirements were established based on a minimum of 50% sulfur amino acids supplied by methionine. As to phenylalanine + tyrosine requirements, the first must also supply at least 50% of the requirements.
- \* Lysine was used as reference to estimate the nutritional requirements of the amino acids. Lysine requirements were determined in several dose-response trials with swine of different ages. The requirement of the other amino acids was then based on the concept of Ideal Protein, maintaining for each type of pig the Amino Acid / Lysine Ratio, expressed on total and true digestibility basis.
- \* For swine in the starter, grower and finisher phases, firstly all dose-response experiments with lysine were compiled and daily intake of digestible lysine was determined. Then, lysine maintenance requirements were calculated and obtained the amount of digestible lysine / kg of gain. The results of 17 dose-response experiments, 9 with gilts and 8 with barrows, were used for these determinations. Tables 61 and 63 show the methodology used to calculate the amount of true digestible lysine / kg weight gain of barrows and gilts, respectively. The equations used to estimate true digestible lysine requirements of barrows and gilts according to performance are presented in Tables 62 e 64.
- \* The use of equations to estimate true digestible lysine requirement of pigs allows more flexibility, because in reality there is not only one

single requirement, but many as a function of performance and feed intake. As an example of the variation of lysine requirements, performance data of barrows and gilts are shown. To make easier the manipulation of the Brazilian Tables, examples of requirements for the starter, grower, and finisher phases of pigs with below average, standard, and high performance are presented.

- \* In the case of gestating and lactating sows, requirements are expressed as amount of nutrient per head per day for adequate reproductive performance (Tables 77 and 78). Tables 79 and 80 present the nutritional requirements of gestating and lactating sows when daily feed intake is known.
- \* In nutritional requirement studies, there is a strong influence of environmental temperature on the performance of growing and finishing swine. Temperatures above the optimal for a given rearing stage, result in a decrease of feed intake caused by lower energy requirements for maintenance. There are correction factors to estimate nutritional requirements for swine raised under high environmental temperatures, but examples are not shown here because if performance and feed intake are known, optimal nutritional levels can be easily calculated using the tables mentioned in this book.
- \* Correction factors to determine swine requirements should be also established for temperatures below 21°C. However, it was considered that the stress caused by high temperatures is more significant under Brazilian circumstances. In the case of gilts and sows, energy requirements are lower when environmental temperature is above 16°C up to a limit of 27°C.
- \* A simplified and practical table of swine nutritional requirements is presented at the end of this publication (Chapter 4 - Table 84), allowing a rapid and easy check of the dietary nutritional levels commonly recommended in Brazil.

## **Nutritional Requirements of Growing Swine**



Table 61 - Methodology Used to Obtain the Equation that Calculates the True Digestible Lysine / kg of Weight Gain of Barrows of High Genetic Potential

Weight, kg	15 - 30	30 - 60	60 - 95	95 - 125
Experiments UFV <sup>1</sup>	3	2	2	1
Average Weight in the Phase, kg	22.5	45	77.5	110
Feed Intake, g/day	1100	1954	2800	3057
Dig. Lys. Intake of g/day	12.43	20.62	25.20	21.40
Dig. Lysine Maintenance, g/day <sup>2</sup>	0.372	0.625	0.940	1.223
Dig. Lysine for Gain, g/day	12.058	19.995	24.914	20.673
Average Gain, kg/day	0.748	0.997	1.160	0.976
g. Dig. Lys. / kg Gain	16.131	20.061	20.914	20.673
Equation, g Lys / kg Gain	16.293	19.500	21.271	19.662

Equation:  $Y = 11,467 + 0.2505 \times (W) - 0.0016 \times (W)^2$   $R^2 = 0.89$   
 being Y = g Dig. Lys. / kg Gain; W = Body Weight, kg.

<sup>1</sup> Total of 8 dose-response experiments with different lysine levels.

<sup>2</sup> Daily requirement of digestible lysine for maintenance =  $0.036 \times (\text{Body Weight})^{0.75}$ .  
 Estimated from the values of Fuller et al. 1989 (British J. Nutr. 62:255).

Table 62 - Equation Used to Estimate True Digestible Lysine (Dig. Lys.) Requirement of Barrows of High Genetic Potential

---

$$\text{Dig. Lys. (g/day)} = 0.036 \times W^{0.75} + (\text{g. Dig. Lys./kg Gain}) \times G$$

W = Average Body Weight in kg

$$\text{g. Dig. Lys. / kg Gain} = 11.467 + 0.2505 \times (W) - 0.0016 \times (W)^2$$

G = Gain / day in kg

Example: Barrows

Average Weight = 50 kg, being  $W^{0.75} = 18.803$

$$\text{g. Dig. Lys./kg Gain} = 11.467 + 0.2505 (50) - 0.0016 (50)^2 = 19.992 \text{ g.}$$

$$G = 0.900 \text{ kg}$$

$$\text{Dig. Lys. Req.} = 0.036 \times 18.803 + (19.992 \times 0.900) = 18.67 \text{ g/day}$$

$$\text{Estimated Intake} = 2130 \text{ g/day}$$

$$\% \text{ Dig. Lys. in the Diet} = 0.876\%$$

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Table 63 - Methodology Used to Obtain the Equation that Calculates the True Digestible Lysine / kg of Weight Gain of Gilts of High Genetic Potential

Weight, kg	15 - 30	30 - 60	60-95
Experiments UFV <sup>1</sup>	3	3	3
Average Weight in the Phase, kg	22,5	45	87,5
Feed Intake, g/day	1100	1949	2491
Intake of Dig. Lys., g/day	12,43	21,83	22,67
Dig. Lysine Maintenance, g/day <sup>2</sup>	0,372	0,625	0,940
Dig. Lysine for Gain, g/day	12,058	21,205	21,730
Average Gain, kg/day	0,748	0,972	1,001
g. Dig. Lys. / kg Gain	16,131	21,816	21,704
Equation, g Lys / kg Gain	16,130	21,772	21,878

Equation:  $Y = 5.9314 + 0.5545 \times (W) - 0.0045 \times (W)^2$   $R^2 = 0.96$   
 being Y = g. Dig. Lys. / kg Gain; W = Body Weight, kg.

<sup>1</sup> Total of 9 dose-response experiments with different lysine levels.

<sup>2</sup> Daily requirement of digestible lysine for maintenance =  $0.036 \times (\text{Average Weight})^{0.75}$ .  
 Estimated from the values of Fuller et al. 1989 (British J. Nutr. 62:255).

Table 64 - Equation Used to Estimate True Digestible Lysine (Dig. Lys.) Requirement of Gilts of High Genetic Potential

---

$$\text{Dig. Lys. (g/day)} = 0.036 \times W^{0.75} + (\text{g. Dig. Lys./kg Gain}) \times G$$

W = Average Body Weight in kg

$$\text{g. Dig. Lys. / kg Gain} = 5.9314 + 0.5545 \times (W) - 0.0045 \times (W)^2$$

G = Gain / day in kg

Exemplo: Gilts

Average Weight = 60 kg, being  $W^{0.75} = 21.558$

$$\text{g. Dig. Lys./kg Gain} = 5.9314 + 0.5545 \times (60) - 0.0045 \times (60)^2 = 23.001 \text{ g.}$$

$$G = 0.910 \text{ kg}$$

$$\text{Dig. Lys. Req..} = 0.036 \times 21.558 + (23.001 \times 0.910) = 21.707 \text{ g/day.}$$

Estimated Intake = 2400 g/day

$$\% \text{ Dig. Lys. in the Diet} = 0.904\%$$

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Table 65 - Digestible Lysine (Dig. Lys.) Requirement of Barrows of High Genetic Potential with Standard Performance Using Equation of Table 62

Week (days)	Weight kg	Gain kg/day	Dig. Lys. Req. g/day	Intake kg/day	Intake ME Mcal/day <sup>1</sup>	Lys/ME Ratio %/Mcal	Dig. Lys. %
08 (56)	18.5	0.547	8.8	0.850	2.75	0.379	1.040
09 (63)	22.6	0.616	10.4	1.052	3.40	0.292	0.992
10 (70)	27.2	0.683	12.1	1.264	4.08	0.235	0.958
11 (77)	32.2	0.745	13.8	1.480	4.78	0.195	0.934
12 (84)	37.7	0.803	15.5	1.696	5.48	0.167	0.914
13 (91)	43.5	0.853	17.1	1.906	6.16	0.146	0.898
14 (98)	49.6	0.897	18.6	2.110	6.82	0.129	0.881
15 (105)	56.1	0.933	19.8	2.308	7.46	0.115	0.860
16 (112)	62.7	0.961	20.9	2.493	8.05	0.104	0.837
17 (119)	69.5	0.980	21.6	2.675	8.64	0.094	0.808
18 (126)	76.4	0.992	22.0	2.929	9.46	0.080	0.753
19 (133)	83.4	0.997	22.1	3.078	9.94	0.072	0.720
20 (140)	90.4	0.994	22.0	3.291	10.63	0.063	0.668
21 (147)	97.3	0.985	21.5	3.425	11.06	0.057	0.628
22 (154)	104.1	0.971	20.8	3.503	11.32	0.052	0.593
23 (161)	110.9	0.951	19.8	3.529	11.40	0.049	0.562
24 (168)	117.4	0.927	18.7	3.567	11.52	0.046	0.525

<sup>1</sup> Diets containing 3230 kcal ME / kg for the Starter, Grower, and Finisher phases.

Table 66 - Digestible Lysine (Dig. Lys.) Requirement of Gilts of High Genetic Potential with Standard Performance Using Equation of Table 64

Week (days)	Weight kg	Gain kg/day	Dig. Lys. Req. g/day	Intake kg/day	Intake ME Mcal/day <sup>1</sup>	Lys/ME Ratio %/Mcal	Dig. Lys. %
08 (56)	18.2	0.542	8.2	0.809	2.61	0.388	1.014
09 (63)	22.3	0.608	10.1	1.003	3.24	0.312	1.012
10 (70)	26.8	0.671	12.2	1.212	3.92	0.257	1.008
11 (77)	31.7	0.729	14.3	1.429	4.62	0.217	1.003
12 (84)	37.0	0.781	16.4	1.647	5.32	0.187	0.995
13 (91)	42.7	0.825	18.3	1.875	6.06	0.161	0.973
14 (98)	48.6	0.862	19.8	2.089	6.75	0.141	0.950
15 (105)	54.8	0.890	21.0	2.285	7.38	0.125	0.920
16 (112)	61.1	0.911	21.7	2.441	7.88	0.113	0.890
17 (119)	67.5	0.932	22.1	2.515	8.12	0.108	0.880
18 (126)	74.1	0.944	22.0	2.548	8.23	0.105	0.862
19 (133)	80.7	0.941	21.1	2.590	8.37	0.097	0.813
20 (140)	87.3	0.932	19.7	2.656	8.58	0.087	0.742
21 (147)	93.7	0.917	17.9	2.724	8.80	0.075	0.658

<sup>1</sup>Diets containing 3230 kcal ME / kg for the Starter, Grower, and Finisher phases.

Table 67 - Amino Acid / Lysine Ratio Used to Estimate Amino Acid Requirements of Growing Swine

Phase Amino Acid	Starter		Grower		Finisher	
	Digestible	Total	Digestible	Total	Digestible	Total
Lysine	100	100	100	100	100	100
Methionine	28	27	30	29	31	30
Met + Cys	56	55	60	59	62	61
Tryptophan	17	17	18	18	19	19
Threonine	63	67	65	69	67	71
Arginine	42	40	41	39	32	30
Valine	69	70	69	70	69	70
Isoleucine	55	55	55	55	55	55
Leucine	100	97	100	97	100	97
Histidine	33	32	33	32	33	32
Phenylalanine	50	49	50	49	50	49
Phenylalan. + Tyrosine	100	98	100	98	100	98

Table 68 - Equations to Estimate the Nutritional Requirements of Growing Pigs (15 to 120 kg) in Percentage / Mcal ME as a Function of Live Weight

Nutrient	Equation <sup>1</sup>
<b>Barrows with Below Average Performance</b>	
Protein <sup>2</sup>	$Y = (6090.6 - 34.304X + 0.1053X^2) / 1000$
<b>Barrows with Standard Performance</b>	
Protein <sup>2</sup>	$Y = (6167.0 - 25.523X + 0.0393X^2) / 1000$
<b>Barrows with High Performance</b>	
Protein <sup>2</sup>	$Y = (6338.2 - 16.527X - 0.0175X^2) / 1000$
<b>Gilts with Below Average Performance</b>	
Protein <sup>2</sup>	$Y = (5816.2 - 15.118X - 0.0544X^2) / 1000$
<b>Gilts with Standard Performance</b>	
Protein <sup>2</sup>	$Y = (6072.6 - 15.215X - 0.0182X^2) / 1000$
<b>Gilts with High Performance</b>	
Protein <sup>2</sup>	$Y = (6098.2 + 0.979X - 0.1615X^2) / 1000$
<b>Growing Barrows and Gilts (15 to 120 kg)</b>	
Calcium	$Y = (266.2 - 2.125X + 0.0089 X^2) / 1000$
Total Phosphorus	$Y = (224.7 - 1.926X + 0.0092 X^2) / 1000$
Avail. Phosphorus	$Y = (152.6 - 1.556X + 0.0078 X^2) / 1000$
Potassium	$Y = (154.9 - 0.427X + 0.0006 X^2) / 1000$
Sodium	$Y = (68.4 - 0.346X + 0.0014 X^2) / 1000$
Chloride	$Y = (65.4 - 0.346 X + 0.0014 X^2) / 1000$

<sup>1</sup> In order to determine nutrient percentage in the diet of the chosen nutritional program, use the equations above. Y = nutrient % per 1.0 Mcal of ME/kg and X = Average weight (kg). The value obtained must then be multiplied by dietary ME in Mcal; Ex.: Calcium requirement for 15-30 kg pig (average weight 22,5kg) is:  $Y = (266.2 - 2.125 (22.5) + 0.0089 (22.5)^2) / 1000 = 0.223\% / \text{Mcal} \times 3.230 \text{ Mcal ME/ kg} = 0.720\%$

<sup>2</sup> Minimum protein levels for diets based on corn and soybean meal when the synthetic amino acids lysine, methionine and threonine are available.

Table 69 - Nutritional Requirements of Piglets of High Genetic Potential in the Pre-Starter Phase with Standard Performance (Barrows and Gilts)

Live Weight. kg		4 a 7	7 a 15
		Nutrient	
Metabolizable Energy	kcal/kg	3325	3325
Protein	%	20.00	21.00
Calcium	%	0.888	0.825
Total Phosphorus	%	0.710	0.650
Avail. Phosphorus	%	0.560	0.450
Potassium	%	0.520	0.500
Sodium	%	0.280	0.230
Chloride	%	0.250	0.220
		Digestible Amino Acid	
Lysine	%	1.520	1.330
Methionine	%	0.426	0.372
Methionine+Cystine	%	0.851	0.745
Tryptophan	%	0.258	0.226
Threonine	%	0.958	0.838
Arginine	%	0.638	0.559
Valine	%	1.049	0.918
Isoleucine	%	0.836	0.732
Leucine	%	1.520	1.330
Histidine	%	0.502	0.439
Phenylalanine	%	0.760	0.665
Phenylal. + Tyrosine	%	1.520	1.330
		Total Amino Acid	
Lysine	%	1.620	1.450
Methionine	%	0.437	0.392
Methionine+Cystine	%	0.891	0.798
Tryptophan	%	0.275	0.247
Threonine	%	1.085	0.972
Arginine	%	0.648	0.580
Valine	%	1.134	1.015
Isoleucine	%	0.891	0.798
Leucine	%	1.571	1.407
Histidine	%	0.518	0.464
Phenylalanine	%	0.794	0.711
Phenylal. + Tyrosine	%	1.588	1.421

Table 70 - Nutritional Requirements of Barrows of High Genetic Potential with Below Average Performance<sup>1</sup>

Phase	Starter		Grower		Finisher						
Live Weight, kg	15 to 30		30 to 50		50 to 70		70 to 100		100 to 120		
Average Weight, kg	22.5		40		60		85		110		
Weight Gain, kg/day	0.574		0.756		0.862		0.871		0.809		
Intake, kg/day	1.032		1.963		2.680		3.197		3.522		
Dig. Lysine Req., g/day	9.724		14.981		18.793		19.439		17.129		
Nutrient											
Metab. Energy, kcal/kg	3230		3230		3230		3230		3230		
Protein, %	17.35		15.80		14.30		12.71		11.60		
Calcium, %	0.720		0.631		0.551		0.484		0.453		
Total Phosphorus, %	0.600		0.524		0.459		0.412		0.400		
Avail. Phosphorus, %	0.400		0.332		0.282		0.248		0.245		
Potassium, %	0.470		0.448		0.425		0.400		0.372		
Sodium, %	0.200		0.180		0.170		0.160		0.150		
Chloride, %	0.190		0.170		0.160		0.150		0.140		
Amino Acid	Dig.	Total	Dig.	Total	Dig.	Total	Dig.	Total	Dig.	Total	
Lysine, %	0.942	1.070	0.758	0.861	0.696	0.791	0.609	0.692	0.486	0.552	
Methionine, %	0.264	0.289	0.227	0.250	0.209	0.229	0.189	0.208	0.151	0.166	
Met + Cys, %	0.528	0.589	0.455	0.508	0.418	0.467	0.378	0.422	0.301	0.337	
Tryptophan, %	0.160	0.182	0.136	0.155	0.125	0.143	0.116	0.132	0.092	0.105	
Threonine, %	0.593	0.717	0.493	0.594	0.452	0.546	0.408	0.491	0.326	0.392	
Arginine, %	0.396	0.428	0.311	0.336	0.285	0.308	0.195	0.208	0.156	0.166	
Valine, %	0.650	0.749	0.523	0.603	0.480	0.554	0.420	0.484	0.335	0.386	
Isoleucine, %	0.518	0.589	0.417	0.474	0.383	0.435	0.335	0.381	0.267	0.304	
Leucine, %	0.942	1.038	0.758	0.836	0.696	0.767	0.609	0.671	0.486	0.535	
Histidine, %	0.311	0.342	0.250	0.276	0.230	0.253	0.201	0.221	0.160	0.177	
Phenylalanine, %	0.471	0.525	0.379	0.422	0.348	0.388	0.305	0.339	0.243	0.270	
Phenylal + Tyrosine,%	0.942	1.049	0.758	0.844	0.696	0.775	0.609	0.678	0.486	0.541	

<sup>1</sup> Nutrient percentage was determined using: Table 62 (Dig. Lys. requirement according to performance), Table 67 (Amino acid / lysine ratios), and Table 68 (Equations - % nutrient / Mcal. ME). Total lysine requirement was calculated considering the average true lysine digestibility of 88%.



Table 71 - Nutritional Requirements of Barrows of High Genetic Potential with Standard Performance <sup>1</sup>

Phase	Starter		Grower		Finisher						
Live Weight, kg	15 to 30		30 to 50		50 to 70		70 to 100		100 to 120		
Average Weight, kg	22.5		40		60		85		110		
Weight Gain, kg/day	0.616		0.825		0.960		0.996		0.953		
Intake, kg/day	1.051		1.810		2.494		3.250		3.571		
Dig. Lys. Req., g/day	10.413		16.194		20.711		22.075		19.959		
Nutrient											
Metab. Energy, kcal/kg	3230		3230		3230		3230		3230		
Protein, %	18.13		16.82		15.43		13.83		12.39		
Calcium, %	0.720		0.631		0.551		0.484		0.453		
Total Phosphorus, %	0.600		0.524		0.459		0.412		0.400		
Avail, Phosphorus, %	0.400		0.332		0.282		0.248		0.245		
Potassium, %	0.470		0.448		0.425		0.400		0.372		
Sodium, %	0.200		0.180		0.170		0.160		0.150		
Chloride, %	0.190		0.170		0.160		0.150		0.140		
Amino Acid	Dig.	Total	Dig.	Total	Dig.	Total	Dig.	Total	Dig.	Total	
Lysine, %	0.991	1.126	0.895	1.017	0.829	0.942	0.679	0.772	0.559	0.635	
Methionine, %	0.278	0.304	0.269	0.295	0.249	0.273	0.211	0.232	0.173	0.191	
Methionine+Cystine %	0.555	0.619	0.537	0.600	0.497	0.556	0.421	0.471	0.347	0.406	
Tryptophan, %	0.168	0.191	0.161	0.183	0.149	0.170	0.129	0.147	0.106	0.121	
Threonine, %	0.624	0.754	0.582	0.702	0.539	0.650	0.455	0.548	0.375	0.451	
Arginine, %	0.416	0.450	0.367	0.397	0.340	0.367	0.217	0.231	0.179	0.191	
Valine, %	0.684	0.788	0.618	0.712	0.572	0.659	0.469	0.540	0.386	0.445	
Isoleucine, %	0.545	0.619	0.492	0.559	0.456	0.518	0.373	0.425	0.307	0.349	
Leucine, %	0.991	1.092	0.895	0.987	0.829	0.914	0.679	0.749	0.559	0.616	
Histidine, %	0.327	0.360	0.295	0.325	0.274	0.301	0.224	0.247	0.184	0.203	
Phenylalanine, %	0.496	0.552	0.448	0.498	0.415	0.462	0.340	0.378	0.279	0.311	
Phenylal + Tyrosine, %	0.991	1.103	0.895	0.997	0.829	0.923	0.679	0.757	0.559	0.622	

<sup>1</sup> Nutrient percentage was determined using: Table 62 (Dig. Lys. requirement according to performance), Table 67 (Amino acid / lysine ratios), and Table 68 (Equations - % nutrient / Mcal. ME). Total lysine requirement was calculated considering the average true lysine digestibility of 88%.

**Table 72 - Nutritional Requirements of Barrows of High Genetic Potential with High Performance <sup>1</sup>**

Phase	Starter		Grower				Finisher			
Live Weight, kg	15 to 30		30 to 50		50 to 70		70 to 100		100 to 120	
Average Weight, kg	22.5		40		60		85		110	
Weight Gain, kg/day	0.750		0.980		1.080		1.080		0.980	
Intake, kg/day	1.100		1.860		2.430		2.950		3.100	
Dig. Lys. Req., g/day	12.592		19.121		23.172		23.903		20.492	
Nutrient										
Metab. Energy, kcal/kg	3230		3230		3230		3230		3230	
Protein, %	19.24		18.25		17.07		15.53		13.92	
Calcium, %	0.720		0.631		0.551		0.484		0.543	
Total Phosphorus, %	0.600		0.524		0.459		0.412		0.400	
Avail. Phosphorus, %	0.400		0.332		0.282		0.248		0.245	
Potassium, %	0.470		0.448		0.425		0.400		0.372	
Sodium , %	0.200		0.180		0.170		0.160		0.150	
Chloride, %	0.190		0.170		0.160		0.150		0.140	
Amino Acid	Dig.	Total	Dig.	Total	Dig.I	Total	Dig.	Total	Dig.	Total
Lysine, %	1.145	1.301	1.028	1.168	0.953	1.083	0.810	0.920	0.661	0.751
Methionine, %	0.321	0.351	0.308	0.339	0.286	0.314	0.251	0.276	0.205	0.225
Met + Cys, %	0.641	0.716	0.617	0.689	0.572	0.639	0.502	0.561	0.410	0.458
Tryptophan, %	0.195	0.221	0.185	0.210	0.172	0.195	0.154	0.175	0.126	0.143
Threonine, %	0.721	0.872	0.668	0.806	0.619	0.747	0.543	0.653	0.443	0.533
Arginine, %	0.481	0.520	0.421	0.456	0.391	0.422	0.259	0.276	0.212	0.225
Valine, %	0.790	0.911	0.709	0.818	0.658	0.758	0.559	0.644	0.456	0.526
Isoleucine, %	0.630	0.716	0.565	0.642	0.524	0.596	0.446	0.506	0.364	0.413
Leucine, %	1.145	1.262	1.028	1.133	0.953	1.050	0.810	0.892	0.661	0.728
Histidine, %	0.378	0.416	0.339	0.374	0.314	0.347	0.267	0.294	0.218	0.240
Phenylalanine, %	0.573	0.638	0.514	0.572	0.477	0.531	0.405	0.451	0.331	0.368
Phenyla. + Tyrosine, %	1.145	1.275	1.028	1.145	0.953	1.061	0.810	0.902	0.661	0.736

<sup>1</sup> Nutrient percentage was determined using: Table 62 (Dig. Lys. requirement according to performance), Table 67 (Amino acid / lysine ratios), and Table 68 (Equations - % nutrient / Mcal. ME). Total lysine requirement was calculated considering the average true lysine digestibility of 88%.

Table 73 - Nutritional Requirements of Gilts of High Genetic Potential with Below Average Performance<sup>1</sup>

Phase	Starter		Grower				Finisher	
Live Weight, kg	15 to 30		30 to 50		50 to 70		70 to 100	
Average Weight, kg	22.5		40		60		85	
Weight Gain, kg/day	0.563		0.735		0.822		0.812	
Intake, kg/day	1.012		1.777		2.500		2.761	
Dig. Lys. Req., g/day	9.453		15.942		19.683		17.696	
Nutrient								
Metab. Energy, kcal/kg	3230		3230		3230		3230	
Protein, %	17.60		16.55		15.22		13.37	
Calcium, %	0.720		0.631		0.551		0.484	
Total Phosphorus, %	0.600		0.524		0.459		0.412	
Avail. Phosphorus, %	0.400		0.382		0.282		0.248	
Potassium, %	0.470		0.448		0.425		0.400	
Sodium, %	0.200		0.180		0.170		0.160	
Chloride, %	0.190		0.170		0.160		0.150	
Amino acid	Dig.	Total	Dig.	Total	Dig.	Total	Dig.	Total
Lysine, %	0.934	1.061	0.897	1.019	0.787	0.894	0.641	0.728
Methionine, %	0.262	0.286	0.269	0.296	0.236	0.259	0.199	0.219
Met + Cys, %	0.523	0.584	0.538	0.601	0.472	0.527	0.397	0.444
Tryptophan, %	0.159	0.181	0.161	0.184	0.142	0.161	0.122	0.138
Threonine, %	0.588	0.711	0.583	0.703	0.512	0.617	0.429	0.517
Arginine, %	0.392	0.425	0.368	0.398	0.323	0.349	0.205	0.219
Valine, %	0.644	0.743	0.619	0.713	0.543	0.626	0.442	0.510
Isoleucine, %	0.514	0.584	0.493	0.560	0.433	0.492	0.353	0.400
Leucine, %	0.934	1.030	0.897	0.989	0.787	0.867	0.641	0.706
Histidine, %	0.308	0.340	0.296	0.326	0.260	0.286	0.212	0.233
Phenylalanine, %	0.467	0.520	0.449	0.499	0.394	0.438	0.321	0.357
Phenylal. + Tyrosine, %	0.934	1.040	0.897	0.999	0.787	0.876	0.641	0.713

<sup>1</sup> Nutrient percentage was determined using: Table 64 (Dig. Lys. requirement according to performance), Table 67 (Amino acid / lysine ratios), and Table 68 (Equations - % nutrient / Mcal. ME). Total lysine requirement was calculated considering the average true lysine digestibility of 88%.

Table 74 - Nutritional Requirements of Gilts of High Genetic Potential with Standard Performance <sup>1</sup>

Phase	Starter		Grower		Finisher			
Live Weight, kg	15 to 30		30 to 50		50 to 70		70 to 100	
Average Weight, kg	22.5		40		60		85	
Weight Gain, kg/day	0.613		0.805		0.914		0.931	
Intake, kg/day	1.108		1.760		2.480		2.640	
Dig. Lys. Req., g/day	10.260		17.395		21.799		20.141	
Nutrient								
Metab. Energy, kcal/kg	3230		3230		3230		3230	
Protein, %	18.50		17.55		16.45		15.01	
Calcium, %	0.720		0.631		0.551		0.484	
Total Phosphorus, %	0.600		0.524		0.459		0.412	
Avail. Phosphorus, %	0.400		0.332		0.282		0.248	
Potassium, %	0.470		0.448		0.425		0.400	
Sodium , %	0.200		0.180		0.170		0.160	
Chloride, %	0.190		0.170		0.160		0.150	
Amino Acid	Dig.	Total	Dig.	Total	Dig.	Total	Dig.	Total
Lysine, %	0.926	1.052	0.988	1.123	0.879	0.999	0.763	0.867
Methionine, %	0.259	0.284	0.296	0.326	0.264	0.290	0.237	0.260
Met + Cys, %	0.519	0.579	0.593	0.663	0.527	0.589	0.473	0.529
Tryptophan, %	0.157	0.179	0.178	0.202	0.158	0.180	0.145	0.165
Threonine, %	0.583	0.705	0.642	0.775	0.571	0.689	0.511	0.616
Arginine, %	0.389	0.421	0.405	0.438	0.360	0.390	0.244	0.260
Valine, %	0.639	0.736	0.682	0.786	0.607	0.699	0.526	0.607
Isoleucine, %	0.509	0.579	0.543	0.618	0.483	0.549	0.420	0.477
Leucine, %	0.926	1.020	0.988	1.089	0.879	0.969	0.763	0.841
Histidine, %	0.306	0.337	0.326	0.359	0.290	0.320	0.252	0.277
Phenylalanine, %	0.463	0.515	0.494	0.550	0.440	0.489	0.381	0.425
Phenylal + Tyrosine, %	0.926	1.031	0.988	1.101	0.879	0.979	0.763	0.850

<sup>1</sup> Nutrient percentage was determined using: Table 64 (Dig. Lys. requirement according to performance), Table 67 (Amino acid / lysine ratios), and Table 68 (Equations - % nutrient / Mcal. ME). Total lysine requirement was calculated considering the average true lysine digestibility of 88%.

Table 75 - Nutritional Requirements of Gilts of High Genetic Potential with High Performance<sup>1</sup>

Phase	Starter		Grower		Finisher			
Live Weight, kg	15 to 30		30 to 50		50 to 70		70 to 100	
Average Weight, kg	22.5		40		60		85	
Weight Gain, kg/day	0.750		0.920		0.980		0.990	
Intake, kg/day	1.075		1.800		2.250		2.490	
Dig. Lys. Req., g/day	12.469		19.811		23.317		21.354	
Nutrient								
Metab. Energy, kcal/kg	3230		3230		3230		3230	
Protein, %	19.5		19.00		18.00		16.20	
Calcium, %	0.720		0.631		0.551		0.484	
Total Phosphorus, %	0.600		0.524		0.459		0.412	
Avail. Phosphorus, %	0.400		0.332		0.282		0.248	
Potassium, %	0.470		0.448		0.425		0.400	
Sodium, %	0.200		0.180		0.170		0.160	
Chloride, %	0.190		0.170		0.160		0.150	
Amino Acid	Dig.	Total	Dig.	Total	Dig.	Total	Dig.	Total
Lysine, %	1.160	1.318	1.101	1.251	1.036	1.177	0.858	0.975
Methionine, %	0.325	0.356	0.330	0.363	0.311	0.341	0.266	0.293
Met + Cys, %	0.650	0.725	0.661	0.738	0.622	0.694	0.532	0.595
Tryptophan, %	0.197	0.224	0.198	0.225	0.186	0.212	0.163	0.185
Threonine, %	0.731	0.883	0.716	0.863	0.673	0.812	0.575	0.692
Arginine, %	0.487	0.527	0.451	0.488	0.425	0.459	0.275	0.293
Valine, %	0.800	0.923	0.760	0.875	0.715	0.824	0.592	0.683
Isoleucine, %	0.638	0.725	0.606	0.688	0.570	0.647	0.472	0.536
Leucine, %	1.160	1.279	1.101	1.214	1.036	1.142	0.858	0.946
Histidine, %	0.383	0.422	0.363	0.400	0.342	0.377	0.283	0.312
Phenylalanine, %	0.580	0.646	0.551	0.613	0.518	0.577	0.429	0.478
Phenylal + Tyrosine, %	1.160	1.292	1.101	1.226	1.036	1.153	0.858	0.955

<sup>1</sup> Nutrient percentage was determined using: Table 64 (Dig. Lys. requirement according to performance), Table 67 (Amino acid / lysine ratios), and Table 68 (Equations - % nutrient / Mcal. ME). Total lysine requirement was calculated considering the average true lysine digestibility of 88%.



## **Nutritional Requirements of Swine Breeders**





Table 76 - Amino Acid / Lysine Ratio Used to Estimate Amino Acid Requirements of Swine Breeders

Amino acid	Gestation		Lactation	
	Digestible	Total	Digestible	Total
Lysine	100	100	100	100
Methionine	27	26	27	26
Met + Cys	54	53	54	53
Tryptophan	19	20	19	20
Threonine	70	74	64	68
Arginine	-	-	59	56
Valine	72	73	78	79
Isoleucine	60	60	59	59
Leucine	100	97	117	114
Histidine	33	32	38	37
Phenylalanine	55	54	57	56
Phenylal. + Tyrosine	100	98	114	112

Table 77 - Nutritional Requirements of Gestating Sows (kcal or g/animal/day)

		Gestation			
		Primiparous		Sows	
Metabolizable Energy <sup>1</sup>	Kcal	6340		7000	
Protein	g	300		285	
Calcium	g	14.9		16.0	
Total Phosphorus	g	12.1		13.0	
Avail. Phosphorus	g	7.9		8.5	
Potassium	g	7.5		8.0	
Sodium	g	3.7		4.0	
Chloride	g	2.8		3.0	
Amino Acid		Digestible	Total	Digestible	Total
Lysine <sup>2</sup>	g	13.3	15.1	12.2	13.9
Methionine	g	3.6	3.9	3.3	3.4
Methionine+Cystine	g	7.2	8.0	6.6	7.4
Tryptophan	g	2.5	3.0	2.3	2.8
Threonine	g	9.3	11.2	8.5	10.3
Valine	g	9.6	11.0	8.8	10.1
Isoleucine	g	8.0	9.1	7.3	8.3
Leucine	g	13.3	14.6	12.2	13.5
Histidine	g	4.4	4.8	4.0	4.4
Phenylalanine	g	7.3	8.2	6.7	7.5
Phenylalan. + Tyrosine	g	13.3	14.8	12.2	13.6

<sup>1</sup> Several factors affect energy requirements during gestation and lactation, such as body weight, litter size and environmental temperature. Energy requirements are lower when environmental temperature is above 16°C up to a limit of 27°C.

<sup>2</sup> Total lysine requirement was calculated considering the average true lysine digestibility of 88%.

Table 78 - Nutritional Requirements of Lactating Sows (kcal or g/animal/day)

		Lactation			
		Primiparous		Sows	
Metabolizable Energy <sup>1</sup>	kcal	15000		18500	
Protein	g	855		1008	
Calcium	g	38.3		45.0	
Total Phosphorus	g	30.6		36.0	
Avail. Phosphorus	g	20.4		24.0	
Potassium	g	14.5		17.0	
Sodium	g	9.8		11.5	
Chloride	g	8.9		10.5	
Amino Acid		Digestible	Total	Digestible	Total
Lysine <sup>2</sup>	g	44.5	50.5	50.9	57.8
Methionine	g	12.0	13.1	13.7	15.0
Methionine+Cystine	g	24.0	26.8	27.5	30.6
Tryptophan	g	8.5	10.1	9.7	11.6
Threonine	g	28.5	34.3	32.6	39.3
Arginine	g	26.3	28.3	30.0	32.4
Valine	g	34.7	39.9	39.7	45.7
Isoleucine	g	26.3	29.8	30.0	34.1
Leucine	g	52.1	57.6	59.6	65.9
Histidine	g	16.9	18.7	19.3	21.4
Phenylalanine	g	25.4	28.3	29.0	32.4
Phenylalan. + Tyrosine	g	50.7	56.6	58.0	64.7

<sup>1</sup> Several factors affect energy requirements during gestation and lactation, such as body weight, litter size and environmental temperature. Energy requirements are lower when environmental temperature is above 16°C up to a limit of 27°C.

<sup>2</sup> Total lysine requirement was calculated considering the average true lysine digestibility of 88%.

Table 79 - Nutritional Requirements of Gestating Sows According to Feed Intake<sup>1, 2</sup>

		Gestation			
		Primiparous		Sows	
Intake g/ day		2100		2300	
Nutrient					
Metabolizable Energy <sup>1</sup>	kcal/ kg	3020		3040	
Protein	%	14.3		12.4	
Calcium	%	0.71		0.70	
Total Phosphorus	%	0.58		0.57	
Avail. Phosphorus	%	0.38		0.37	
Potassium	%	0.36		0.35	
Sodium	%	0.18		0.17	
Chloride	%	0.13		0.13	
Amino Acid		Digestible	Total	Digestible	Total
Lysine <sup>2</sup>	%	0.633	0.719	0.530	0.604
Methionine	%	0.171	0.186	0.143	0.148
Met + Cys	%	0.343	0.381	0.297	0.322
Tryptophan	%	0.119	0.143	0.100	0.122
Threonine	%	0.443	0.533	0.370	0.448
Valine	%	0.457	0.524	0.383	0.439
Isoleucine	%	0.381	0.433	0.317	0.361
Leucine	%	0.633	0.695	0.530	0.587
Histidine	%	0.210	0.229	0.174	0.191
Phenylalanine	%	0.348	0.390	0.291	0.326
Phenylal + Tyrosine	%	0.633	0.705	0.530	0.591

<sup>1</sup> To determine nutrient percentage in the diet, divide the requirements on table 77 (kcal or g/day) by the feed intake; Ex: Dig. Lysine for gestating gilts (13.3 x 100) / 2100 = 0.633%

<sup>2</sup> Total lysine requirement was calculated considering the average true lysine digestibility of 88%.

Table 80 - Nutritional Requirements of Lactating Sows According to Feed Intake<sup>1, 2</sup>

		Lactation			
		Primiparous		Sows	
Intake (g/ day)		4500		5600	
Nutrient					
Metabolizable Energy <sup>1</sup>	kcal/ kg	3330		3300	
Protein	%	19.0		18.0	
Calcium	%	0.85		0.80	
Total Phosphorus	%	0.68		0.64	
Avail. Phosphorus	%	0.45		0.43	
Potassium	%	0.32		0.30	
Sodium	%	0.22		0.21	
Chloride	%	0.20		0.19	
Amino Acid		Digestible	Total	Digestible	Total
Lysine <sup>2</sup>	%	0.989	1.122	0.908	1.032
Methionine	%	0.267	0.291	0.245	0.268
Methionine+Cystine	%	0.533	0.596	0.491	0.546
Tryptophan	%	0.189	0.224	0.173	0.207
Threonine	%	0.633	0.762	0.582	0.702
Arginine	%	0.584	0.629	0.536	0.579
Valine	%	0.771	0.887	0.709	0.816
Isoleucine	%	0.584	0.662	0.536	0.609
Leucine	%	1.158	1.280	1.064	1.177
Histidine	%	0.376	0.416	0.345	0.382
Phenylalanine	%	0.564	0.629	0.518	0.579
Phenylalan. + Tyrosine	%	1.127	1.258	1.036	1.155

<sup>1</sup> To determine nutrient percentage in the diet, divide the requirements on table 78 (kcal or g/day) by the feed intake; Ex: Dig. Lysine for lactating gilts (44.5 x 100) / 4500 = 0.989%

<sup>2</sup> Total lysine requirement was calculated considering the average true lysine digestibility of 88%.



## **CHAPTER 4**

### **Simplified Tables of Feedstuff Composition and Nutritional Requirements of Poultry and Swine**





Table 81 - Composition and Energy Values of the Most Common Feedstuffs Used in Poultry and Swine Diets (as fed)

Feedstuffs	Prot. %	Ca %	P %		ME, Kcal/kg		Total AA %			Dig Lys, %		Dig M+C %		Dig Thr, %	
			Total	Avail	P <sup>1</sup>	S <sup>2</sup>	Lys	Met+Cys	Thr	P <sup>1</sup>	S <sup>2</sup>	P <sup>1</sup>	S <sup>2</sup>	P <sup>1</sup>	S <sup>2</sup>
Corn	8.26	0.03	0.24	0.08	3381	3340	0.24	0.36	0.32	0.21	0.19	0.33	0.32	0.27	0.26
Feather Meal (84%)	83.9	0.29	0.74	0.74	2734	2922	2.40	4.05	3.86	1.70	1.83	2.69	3.23	2.84	3.25
Meat & Bone Meal. (41%)	41.0	10.1	6.8	6.8	1937	2065	1.98	0.80	1.15	1.67	1.40	0.59	0.58	0.88	0.86
Meat & Bone Meal. (45%)	44.5	9.55	4.96	4.96	2445	2332	2.19	0.99	1.36	1.80	1.58	0.77	0.68	1.08	0.94
Poultry By-Product Meal	57.0	4.0	2.66	2.66	3259	3566	3.35	2.02	2.43	2.67	2.51	1.57	1.48	1.92	1.86
Rice Bran	13.2	0.11	1.61	0.32	2534	3111	0.63	0.52	0.49	0.48	0.46	0.38	0.37	0.35	0.35
Sorghum Low Tannin	9.2	0.03	0.26	0.09	3192	3289	0.20	0.32	0.31	0.17	0.16	0.27	0.27	0.26	0.25
Soybean Oil	-	-	-	-	8790	8300	-	-	-	-	-	-	-	-	-
Soybean Full-Fat Toasted	37.0	0.23	0.52	0.17	3281	3706	2.23	1.08	1.47	1.94	1.81	0.90	0.85	1.24	1.15
Soybean Meal (45%)	45.3	0.24	0.53	0.18	2256	3154	2.77	1.27	1.78	2.55	2.53	1.11	1.16	1.57	1.55
Wheat Bran-Midds	15.5	0.14	0.99	0.33	1824	2442	0.62	0.58	0.51	0.47	0.46	0.43	0.46	0.37	0.37
L-Lysine HCL	85.8	-	-	-	3762	4599	79.0	-	-	78.8	77.5	-	-	-	-
DL-Methionine	59.4	-	-	-	4858	5475	-	99.0	-	-	-	98.2	98.5	-	-
L-Threonine	78.1	-	-	-	3067	3802	-	-	98.0	-	-	-	-	96.1	94.7
Limestone	-	38.4	-	-	-	-	-	-	-	-	-	-	-	-	-
Dicalcium Phosphate	-	24.5	18.5	18.5	-	-	-	-	-	-	-	-	-	-	-

<sup>1</sup> P = Poultry.<sup>2</sup> S = Swine.

Table 82 - Nutritional Requirements of Male and Female Broilers with Standard Performance<sup>1</sup>

Age, days	-----Males-----					-----Females-----		
	1-7	8-21	22-33	34-42	43-46	22-33	34-42	43-46
Metab. Energy,kcal/kg	2,950	3,000	3,100	3,150	3,200	3,100	3,150	3,200
Protein, %	22.04	20.79	19.25	17.86	17.24	18.60	17.39	16.86
Calcium, %	0.939	0.884	0.817	0.756	0.728	0.775	0.717	0.691
Avail. Phosphorus, %	0.470	0.442	0.408	0.377	0.363	0.388	0.358	0.345
Sodium, %	0.223	0.214	0.203	0.193	0.189	0.193	0.184	0.180
Digestible Amino Acid								
Lysine, %	1.330	1.146	1.073	1.017	0.970	0.997	0.904	0.857
Methionine, %	0.519	0.447	0.429	0.407	0.388	0.399	0.362	0.343
Met + Cys, %	0.944	0.814	0.773	0.732	0.698	0.718	0.651	0.617
Tryptophan, %	0.213	0.183	0.182	0.173	0.165	0.169	0.154	0.146
Threonine, %	0.865	0.745	0.697	0.661	0.631	0.648	0.588	0.557
Arginine, %	1.397	1.203	1.127	1.068	1.019	1.047	0.949	0.900
Valine, %	0.998	0.860	0.826	0.783	0.747%	0.768	0.696	0.660
Total Amino Acid								
Lysine, %	1.466	1.263	1.183	1.121	1.069	1.099	0.997	0.945
Methionine, %	0.572	0.493	0.473	0.448	0.428	0.440	0.399	0.378
Met + Cys, %	1.041	0.897	0.852	0.807	0.770	0.791	0.718	0.680
Tryptophan, %	0.235	0.202	0.201	0.191	0.182	0.187	0.169	0.161
Threonine, %	0.997	0.859	0.804	0.762	0.727	0.747	0.678	0.643
Arginine, %	1.495	1.288	1.207	1.143	1.090	1.121	1.017	0.964
Glycine + Serine, %	2.199	1.895	1.656	1.569	1.443	1.539	1.396	1.276
Valine, %	1.114	0.960	0.923	0.874	0.834	0.857	0.778	0.737

Table 83 - Nutritional Requirements of Replacement Pullets, Layers and Broiler Breeders

Weeks / Intake	Replacement Pullets			White-Egg Layers		Broiler Breeders	
	Starter	Grower	Develop	103 <sup>2</sup>	110 <sup>2</sup>	Hens Cockerels	
	1-6 <sup>1</sup>	7-12 <sup>1</sup>	13-16 <sup>1</sup>			160 <sup>2</sup>	130 <sup>2</sup>
Metabo. Energy,kcal/kg	2,900	2,900	2,900	2,900	2,800	2,750	2,750
Protein, %	18.00	16.00	14.00	16.02	15.00	13.13	12.61
Calcium, %	0.940	0.832	0.800	3.90	3.66	2.56	0.50
Avail. Phosphorus, %	0.437	0.392	0.310	0.364	0.341	0.250	0.231
Sodium, %	0.180	0.160	0.150	0.218	0.205	0.156	0.177
Digestible Amino Acid							
Lysine, %	0.876	0.621	0.483	0.773	0.661	0.573	0.357
Methionine, %	0.350	0.273	0.217	0.387	0.331	0.275	0.206
Met + Cys, %	0.640	0.497	0.396	0.703	0.602	0.499	0.375
Tryptophan, %	0.158	0.124	0.106	0.178	0.152	0.132	0.104
Threonine, %	0.587	0.422	0.333	0.510	0.436	0.464	0.345
Arginine, %	0.937	0.671	0.531	0.773	0.661	0.659	0.501
Valine	0.666	0.497	0.396	0.696	0.652	0.516	0.452
Total Amino Acid							
Lysine, %	0.973	0.690	0.537	0.868	0.743	0.644	0.404
Methionine, %	0.389	0.304	0.242	0.425	0.364	0.303	0.229
Met + Cys, %	0.710	0.552	0.446	0.781	0.669	0.554	0.417
Tryptophan, %	0.175	0.138	0.118	0.200	0.171	0.148	0.118
Threonine, %	0.681	0.490	0.387	0.590	0.505	0.541	0.406
Arginine, %	1.022	0.731	0.575	0.833	0.713	0.702	0.538
Glycine + Serine, %	1.265	0.828	0.591	0.694	0.594	0.683	0.789
Valine, %	0.759	0.559	0.446	0.825	0.706	0.599	0.512

1- Age in weeks. 2 - Intake (g/ day).

**Table 84 - Nutritional Requirements of Swine with High Genetic Potential**

Phase	Pre-Starter <sup>1</sup>	Starter <sup>1</sup>	Grower <sup>1</sup>	Finisher <sup>1</sup>	Sows			
					Gestation	Lactation		
Body Weight , kg	7 to 15	15 to 30	30 to 50	50 to 70	70 to 100	100 to 120	2300 <sup>2</sup>	5600 <sup>2</sup>
Metab. Energy,kcal/kg	3,325	3,230	3,230	3,230	3,230	3230	3,040	3,300
Protein, %	21.00	18.13	16.82	15.43	13.83	12.39	12.40	18.00
Calcium, %	0.825	0.720	0.631	0.551	0.484	0.453	0.700	0.800
Total Phosphorus, %	0.650	0.600	0.524	0.459	0.412	0.400	0.570	0.640
Avail. Phosphorus, %	0.450	0.400	0.332	0.282	0.248	0.245	0.370	0.430
Sodium, %	0.230	0.200	0.180	0.170	0.160	0.150	0.170	0.210
Digestible Amino Acid								
Lysine, %	1.330	0.991	0.895	0.829	0.679	0.559	0.530	0.908
Methionine, %	0.372	0.278	0.269	0.249	0.211	0.173	0.143	0.245
Met + Cys, %	0.745	0.555	0.537	0.497	0.421	0.347	0.297	0.491
Tryptophan, %	0.226	0.168	0.161	0.149	0.129	0.106	0.100	0.173
Threonine, %	0.838	0.624	0.582	0.539	0.455	0.375	0.370	0.582
Arginine, %	0.559	0.416	0.367	0.340	0.217	0.179	-	0.536
Valine, %	0.918	0.684	0.618	0.572	0.469	0.386	0.383	0.709
Total Amino Acid								
Lysine, %	1.450	1.126	1.017	0.942	0.772	0.635	0.604	1.032
Methionine, %	0.392	0.304	0.295	0.273	0.232	0.191	0.148	0.268
Met + Cys, %	0.798	0.619	0.600	0.556	0.471	0.406	0.322	0.546
Tryptophan, %	0.247	0.191	0.183	0.170	0.147	0.121	0.122	0.207
Threonine, %	0.972	0.754	0.702	0.650	0.548	0.451	0.448	0.702
Arginine, %	0.580	0.450	0.397	0.367	0.231	0.191	-	0.579
Valine, %	1.015	0.788	0.712	0.659	0.540	0.445	0.439	0.816

<sup>1</sup> Barrows of standard performance.<sup>2</sup> Intake animal/ day.

## **CHAPTER 5**

### **Theses**



## Master and Ph.D. Theses

Research developed in the graduate program of the Animal Science Department, Federal University of Viçosa, at M.Sc. and Ph.D. levels, generated information on the chemical composition, energy and digestible amino acid content of feedstuffs, as well as on nutritional requirements of poultry and swine of different ages. Models used for nutritional requirement estimations were also tested. All this information was used to prepare the Brazilian Tables.

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