THE PREDICTION OF NUTRITIVE VALUE OF RABBIT DIETS FROM TABLES OF FEED COMPOSITION

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ABSTRACT

427 diets from 134 papers on fattening rabbits published since 1968 in the main research journals were examined, in which the composition of each diet was experimentally determined, and all the ingredients of diets were listed. The following aspects were studied: experimental analyses found the diets, prediction equations for Digestible Energy (DE) and Protein (DCP) deduced from the rest of chemical fractions and a validation of Tables of Feed Composition. This last evaluation was carried out comparing the experimental value of DE or DCP reported in the papers and their calculated value asigning to the ingredients of the diets the values reported in a Table of Feed Composition. The main conclusions were: i) very few diets had an acceptable set of analysis of the nutritive fractions; ii) the values for DE and DCP deduced from values of other nutritive fractions were similar to those already published; iii) the comparison of experimental values of diets and those deduced from a Table of Feed Composition gave a low prediction response. The utilization of tables of feeds for calculation of digestible energy of a diet seem to require a more close description of its ingredients.

Key words: nutritive value, prediction, chemical composition.

INTRODUCTION

Besides the in vivo experimental determination of the nutritive value of ingredients and diets, and the use in vitro or NIRs techniques to estimate them, the only way to asses the nutritive value of diets is either to apply a regression equation (having previously analysed some fraction, i.e. fibre) or to rely on a Table of Feed Composition. Some regression equations have been published for raw materials (FERNÁNDEZ *et al.*, 1996) and more often for complete diets (BATTAGLINI AND GRANDI, 1984; MAERTENS *et al.*, 1988; ORTIZ and DE BLAS, 1989), which usually have been obtained from experimental works already published, predicting the value of digestible energy (DE) through crude fibre (CF) or acid detergent fibre (ADF), corrected sometimes with other fractions that may improve the accuracy of the equation.

The nutritive value of many ingredients has been determined so that complete diets can be formulated, and from time to time some Tables of Feed Composition have been published, with up-to-date values of a list of feedstuffs. Tables are currently used when the experimental value of a diet is not known, but the confidence in their utilization is limited and in experimental work is largely preferred to determine the nutritive value of diets instead of calculating it from the values already published for the ingredients.

The error involved in using these tables has not been assessed, because we cannot compare an experimental "true" value with that deduced from the tables, partially due to the common origin of the values, which are seldom cited, and also because it is a hard work to make a file with a high number of data; certainly we should wonder what is in fact the actual value of the Tables and the effort involved about. In the last years a considerable number of ingredients and diets in experimental works mainly on fattening and reproduction have been analysed, and apparently it seems that they should be examined trying to deduce some conclusion from them.

Therefore, the present work is based in the exam of research works about the utilisation of diets or ingredients for fattening rabbits, selecting those that had experimentally determined nutritive values of the diets tested, to examine the following aspects:

- Diets: nutritive fractions that have been often determined
- Regression equations: prediction of the values of digestible energy (DE) and digestible crude protein (DCP) from the analyses of some nutritive fractions of the diet
- Validation of Tables of Feeds: comparison between the nutritive composition obtained experimentally in the diets so far examined and the correspondent value, calculated from the composition of their ingredients given in a Table of Feed Composition.

MATERIAL AND METHODS

Most papers on fattening rabbits published since 1968 in the main research journals (Journal of Applied Rabbit Research, World Rabbit Science, Cuni-Science, Journal of Animal Science, Animal Feed Science and Technology, and World Rabbit Congresses) were examined, in which the composition of each diet was experimentally determined, all the ingredients of diets were listed, they did not have the objective to determine the nutritive value of an ingredient and they contained no meat meal or related products. At the end, 134 papers from 22 countries, including 427 diets were selected. A file, in which experimental and calculated values were affected by the respective subscripts "e" and "c", was created identifying the ingredients to those found in the Tables of Raw Materials published by INRA (2002).

In the first part of the present work, besides a brief exam of the available data, several equations to predict the DE and DCP from the experimental composition of the diets, in a similar way to that followed by the authors above mentioned, were deduced from that file. The second part of the present work was related to the exam of the Table of Feeds. The composition of diets has been calculated from the theoretical values of the ingredients included in the Table of Feeds, and subsequently compared to the experimental values. Simple and multiple regression equations have been obtained applying the STATGRAPHICS PLUS (1990) system.

RESULTS AND DISCUSSION

Diets

Soybean meal, wheat bran, barley, alfalfa dehydrated or hay, maize, DL-methionine, vegetable oil, wheat straw and molasses were the ingredients most commonly found. The different nutritive fractions of diets expressed in % dry matter (DM) varied between ample limits: ether extract (EE) 1.2-20.4, ADF 3.8-48.0, CP 10.2-37.8, and DE from 1270 to 3495 Kcal/g DM. Protein content was determined in most diets (99%), but only about 30% of them had an experimental value for DE and 5.4% for starch.

Prediction of DE

Simple correlations with a relatively high coefficient (R) were observed between starch and the rest of the fractions (-0.77, 0.66 and 0.70 with NDF, DCP and DE respectively), but unfortunately very few analysis for starch were reported in the diets. The correlation between digestible energy (DE) and a single fraction was the highest for ADF (R= -0.75) and it is coincident with results reported elsewhere.

Some multiple regression equation between DE and all the fractions were obtained, from which one of the best equations was: $DE_e = 2823 – 40.8\ ADF_e – 25.7\ ADL_e + 47.4\ CP_e$ (n= 58, R^2 = 77.4 %, RSE = 121.6), where DE is in Kcal/g DM and the rest of the values are in percentage of dry matter (DM).

The coefficient of correlation was lower than that reported by DE BLAS *et al*. (1992) using the same variables. Using the same diets, where the values for ADF, ADL, CP and EE were given, the value of introducing the EE fraction can be estimated. The result showed that for n=54, R^2 and RSE improved to 84.4 % and 101 respectively. A similar calculation, using the same diets, showed that including NDF fraction did not improved the prediction.

Probably the best equation was deduced with the stepwise procedure which selected the variables. ADF was the best single predictor, as it could be deduced from the coefficients of correlation commented above, but the equation using the same diets than before was not particularly reliable: $DE_e = 3831 – 55.0\ ADF_e$ (n = 58, R^2 = 68.7, RSE = 143.0). Using all diets where ADF was determined, the general equation for predicting digestible energy was. $DE_e = 3647– 45.9\ ADF_e$ (n = 112, R^2 = 57.9, RSE = 188.9). This equation, expressed in kilojoules, has been included in Table 1, where it shows a great similarity to those equations already published.

The coefficient of correlation increased up to 80.6 when this DE equation included the value of both ADF and starch, confirming the idea that this fraction could be a useful help, and also its accuracy improved when some diets were discharged from the file (n = 85, R^2 = 67, RSE = 143). Certainly to remove some values it is not permissible without good reasons, but the interesting point was that almost all outlier values belonged to diets with some particular ingredient that could be easily wrongly evaluated (chick-pea, grass meal, hay) or could introduce some distortion (beet pulp, citrus pulp) to the results.

Something similar was reported by DE BLAS *et al*. (1992) who found that diets with levels of fat, beet pulp, citrus pulp and straw higher than 20% fitted poorly to the equations.

Table 1: Regression equations in the literature.

DE (MJ/Kg MS)	RSD	ADF range (%)	n	Reference
15.8 – 0.22 ADF		12 - 27	29	BATTAGLINI and GRANDI, 1984
6.3--0.22 ADF + 0.49 GE[A]	0.43	8 - 26	36	CORINO, 1987
15.2 – 0.20 ADF	0.47	15 - 39	31	MAERTENS *et al*., 1988
14.9 –0.22 ADF+ 0.35 EE[A]		18 - 26	25	DE BLAS *et al*., 1992
15.9 – 0.22 ADF	0.39	9 - 50	18	FERNÁNDEZ *et al*., 1996
15.3 – 0.19 ADF	0.79	4 - 48	112	Present work

[A] including in the analysis GE (gross energy) or EE (ether extract)

Prediction of digestible protein

The predition equation for dCP_e, when only ADF_e and CP_e were introduced as independent variables, was: $DCP_e = - 1.15 + 0.82\ CP_e - 0.06 \cdot ADF_e$ (n = 84; R^2 = 69.6; RSE = 0.92), where all variables have been expressed in % Dry Matter. This equation could be recommended instead of the first one, although the error continues to be large, due in part to the fact that the ADF fraction showed low correlation with DCP.

Validation of Table of Feeds

The whole set of equations that relate the experimental values and the calculated values using the Table of Feeds defined before are included in Table 2, where it can be observed that the values are quite low for the regression coefficient and high for the standard error. It also seems that DE_c calculated values were consistently lower

The first conclusion is that the fractions calculated in this way are highly unpredictable, with the exception of the fat fraction, which otherwise is not too much interesting. However, it is probably possible to obtain values with lower error, considering that some of the ingredients could be defined more closely to their value through some characteristic of quality or defining better the processing. In fact, forages in most diets did not have any indication about its quality. Some examples were DE value of wheat bran which can vary enormously (BLAS *et al*., 2000) and dehydrated lucerne, grass or hay had very often a confused definition, with no indication about its quality.

From the Figure 1 it may be observed that some calculated values are very different to the experimental values; they were identified from a residual plot, and all they are related either to pulps, ambiguous forages (grass-meal) or obviously erroneous data. Most of them were underestimated in the calculation from the Table. When removing these diets (in red in the Figure) the equation logically improved (see Table 2). Another attempt to make a better prediction should be to introduce in the equations the calculated values for other fractions such as CP_c, ADF_c, NDF_c and EE_c, but the improvements were found to be far from relevant. The predictions for CP or DCP were both very poor, having diets with added fat or brewer's pulp particularly unreliable values. Figure 1: Regression between the digestible energy (Mcal/g DM) experimentally determined (DEe) and calculated (DEc) from Tables of Feeds

Table 2: Regression equations

Equation	No. diets	R^2	RSE
$EE_e = 0.56 + 0.92 \cdot EE_c$	323	76.8	1.23
$CF_e = 5.87 + 0.57 \cdot CF_c$	271	48.6	2.72
$NDF_e = 11.2 + 0.57 \cdot NDF_c$	105	23.7	5.64
$ADF_e = 6.95 + 0.60 \cdot ADF_c$	134	56.7	2.89
$ADL_e = 0.81 + 0.85 \cdot ADL_c$	87	40.9	1.71
$Starch_e = 17.5 + 0.29 \cdot Starch_c$	29	17.0	6.14
$CP_e = 10.7 + 0.42 \cdot CP_c$	415	34.8	2.08
$dCP_e = 0.73 + 0.06 \cdot dCP_c$	147	6.1	1.97
$DE_e = 1531 + 0.45 \cdot DE_c^{A}$	116	24.7	249.5
$DE_e = 728 + 0.74 \cdot DE_c^{B}$	92	60.1	149.5

^{A} equation represented in Figure 1.
^{B} equation without red points in Figure 1.

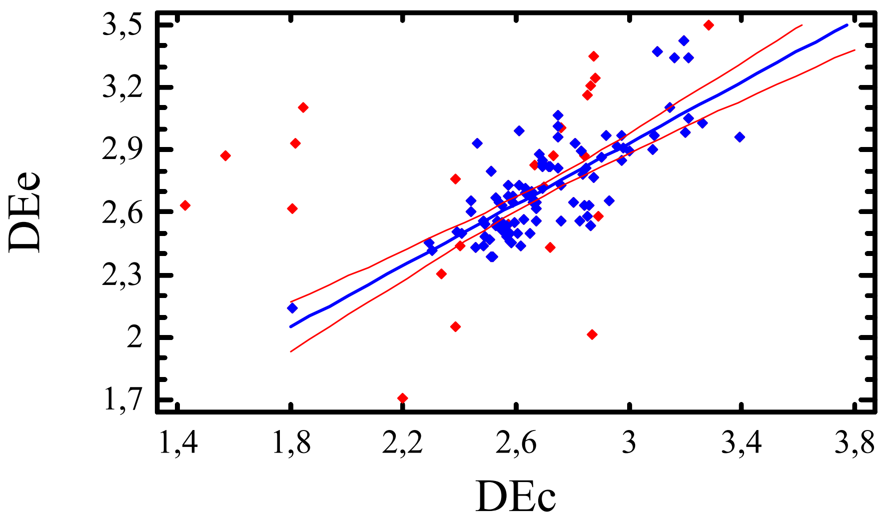

Figure 1: Regression between the digestible energy (Mcal/g DM) experimentally determined (DEe) and calculated (DEc) from Tables of Feeds

It seems as a conclusion from the present work that the prediction of DE from some other nutritive fractions of the diet can be quite acceptable, but from the Table of Feeds is too inaccurate, although it may serve as a guide; a more rigorous description of the ingredients seems to be unavoidable.

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