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Prediction of the nutritional value of European compound feeds for rabbits by chemical components and *in vitro* analysis

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ABSTRACT

Chemical composition and *in vitro* analyses were used to predict the nutritional value of 164 experimental rabbit diets evaluated in six European Laboratories under standardised conditions. The equations were mainly developed by stepwise regression analysis with over two third of the samples (111) used as calibration set. The other third (53) was used as validation set, and a study of the residues was undertaken to calculate the error of validation. Twenty three different equations have been proposed to predict the nutritional value (mainly gross energy digestibility, GEd; and digestible energy, DE) of rabbit diets, as a function of the available variables. Acid detergent fibre (ADFom) was the chemical variable most closely related to GEd and DE (R^2 = 0.49 and 0.43, respectively, RSD = 0.033 and 0.62, for GEd and DE, respectively), but the *in vitro* DM digestibility (DMd_{inv}) predicted the energy value with greater

Abbreviations: ADFom, acid detergent fibre expressed exclusive of residual ash; aNDFom, neutral detergent fibre assayed with a heat stable amylase and expressed exclusive of residual ash; DE, digestible energy; DCP, digestible CP; DM, dry matter; DMd, DM digestibility; DMd_{inv}, DMd *in vitro*; CP, crude protein; CPd, CP digestibility; EE, ether extract; GE, gross energy; GEd, GE digestibility; Lignin (sa), acid detergent lignin determined by solubilization of cellulose with sulphuric acid; NFC, non-fibre carbohydrate; OM, organic matter; RES, residue estimated as (OM–CP–EE–aNDFom–Starch); RSD, residual standard deviation.

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accuracy (R^2 = 0.7, 0.52, for GEd and DE, respectively) and lower standard error (RSD = 0.025, 0.58 for GEd and DE, respectively). The latter equations were improved (R^2 = 0.81, 0.74 for GEd and DE, respectively) when ether extract (EE) and Lignin (sa) were included. The use of additive equations that predict the DE from the main constituents that supply energy (protein, ether extract and carbohydrates) did not increase the precision, nor decrease the validation error respect to the simplest ones. Digestible Energy was predicted with a similar accuracy and validation errors than GEd. Crude protein digestibility (CPd) was better predicted from chemical analysis (Lignin (sa), R^2 = 0.49) than for $DMd_{inv.}$ The further inclusion of CP slightly increased its coefficient of determination (0.53). The error of validation was relatively low (0.050 as average) and of the same magnitude than the RSD of the equations.

1. Introduction

Prediction of the nutritional value of diets and raw materials is one of the main goals in practical animal nutrition in order to provide the farmer and advisory services with cost-effective diets. The European legislation for quality control of feeds includes some chemical determination on the label, which implies an indirect indication of their nutritional value. In order to accomplish both topics, there have been many studies undertaken for predicting the nutritional value of feeds through chemical analysis (FEDNA, 2003; INRA, 2002). Analysing few chemicals (CP and fibre) has been employed for feed quality control and estimating the nutritive value for different animal species using specific equations. Some examples for rabbit feeds have been published by De Blas et al. (1992), Fernandez-Carmona et al. (1996), Villamide and Fraga (1998). Most of these equations are devoted to the prediction of energy value based on fibre (ADFom). These equations are robust and stable for different data sets, however they underestimate fat-supplemented diets or those rich in soluble fibre (De Blas et al., 1992).

Similarly some attempts have been made to simulate the digestion process in laboratories (Tilley and Terry, 1963; Boisen, 1991) and obtain *in vitro* digestibility values with good relationships with those determined *in vivo*. An *in vitro* method, adapted from Boissen, was developed by Ramos et al. (1992) for rabbits, obtaining a high correlation among *in vitro* and *in vivo* DM digestibility (r = 0.93, n = 41) even for diets rich in fat or pulps.

Most recently, during the 1970s and 1980s the development of the use of Near Infrared Reflectance Spectroscopy (NIRS) for prediction of chemical composition was extended into predicting the nutritional value of feeds for rabbits (Xiccato et al., 1999, 2003). Thus, most chemical components and digestible energy (DE) were predicted with high precision (R^2 > 0.7), but poor results were obtained for aNDFom and CP digestibility.

The current study was developed in the context of a Concerted Action (FAIR3-1651-ERAFE) among six laboratories from 5 countries. After creating a sample bank of *in vivo* evaluated diets, they were used to compare the efficacy of different techniques: chemical composition, *in vitro* analysis and NIRS, in predicting the nutritional value of compound diets for rabbits in order to offer quick and effective tools for feed evaluation.

The aim of the present study was to test the efficacy of an *in vitro* method and of chemical composition on predicting the nutritional value of rabbit diets, using different diets for calibration and validation of the methods.

2. Material and methods

2.1. Feeds

One hundred and seventy-seven compound feeds of growing and doe rabbits belonging to the EGRAN sample bank (http://www.dcam.upv.es/egran/saba.htm) were used. The samples came from