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Energetic values of feedstuffs for broilers determined with *in vivo* assays and prediction equations

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ABSTRACT

Two experiments were conducted to test the suitability of a set of prediction equations to predict the nitrogen-corrected apparent metabolizable energy (AMEn) of protein and energetic ingredient concentrates used by the poultry feed industry. Nine protein concentrates and nine energetic concentrates were evaluated in six replicates each via substitution for 300 and 400 g/kg of the basal diet, respectively. These values were compared to the AMEn estimated via equations that utilized data on the chemistry composition of the feedstuffs. All the equations were efficient in estimating the AMEn values of the tested feedstuffs. We concluded that the prediction equations studied can be utilized to estimate the AMEn of protein and energetic concentrate ingredients used by the poultry feed industry. The equation AMEn = 4101.33 + 5.628EE−23.297ASH−2.486aNDFom + 1.042ADFom (R^2 = 0.84; RSD = 0.4137; P-value<0.0001; n = 574) was most applicable in the prediction of energetic values of evaluated feedstuffs.

1. Introduction

The production of poultry meat throughout the world is growing significantly because of the increased world-wide demand for food. Brazil is the third largest producer in this market, contributing around 11.3 million tons of meat and exporting more than 3.6 million tons each year (USDA, 2009). However, to adequately meet the nutrient requirements of animals, it is necessary to elaborate diets that improve the nutrient utilization and the bird's performance and decrease the pollutant power of this activity.

Dietary energy level is the main factor influencing feed intake. Therefore, dietary nutrients (protein, amino acids, vitamins and minerals) should vary depending on the energy content of the diet. The model most frequently used to express the energetic values of feedstuffs for broilers is the metabolizable energy (ME) model. Nevertheless, metabolic bioassays are necessary to determine the ME of these ingredients, but these are onerous and require time. Thus, tables are commonly used to obtain the energetic values of ingredients used in diets. However, several factors can affect table values, including the

Abbreviations: ADFom, acid detergent fiber exclusive of residual ash; AOAC, Association of Official Analytical Chemists; AME, apparent metabolizable energy; AMEn, nitrogen-corrected AME; DM, dry matter; CP, crude protein; CF, crude fiber; EE, ether extract; GE, gross energy; aNDFom, neutral detergent fiber assayed with heat stable amylase exclusive of residual ash; R^2, coefficient of determination of regression.

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Table 1
Chemistry and energetic composition of protein concentrate feedstuffs (g/kg, DM).[a,b]

Feedstuff	Composition							
	DM	GE (MJ/kg)	CP	EE	CF	aNDFom	ADFom	Ash
Soybean meal 1	876.3	18.15	471.6	13.7	75.8	164.6	97.4	66.1
Soybean meal 2	882.0	18.42	493.2	19.6	51.6	153.6	88.0	66.8
Soybean meal 3	891.4	18.17	474.3	19.5	50.2	149.5	92.0	64.7
Soybean meal 4	887.0	18.08	479.4	19.8	56.6	149.1	94.3	61.9
Semi-integral soybean meal	907.6	19.31	426.2	102.4	89.7	156.4	101.1	57.4
Full-fat extruded soybean	910.7	21.91	359.6	212.5	72.0	157.7	102.8	54.5
Texturized soybean protein	930.6	18.57	533.1	7.5	11.7	41.5	24.4	57.6
Integral micronized soy	939.2	23.06	398.5	258.5	13.8	198.7	55.6	53.5
Maize gluten meal	899.3	22.51	687.0	34.1	13.3	64.8	105.7	16.2
Average	902.7	19.80	480.3	76.4	48.3	137.3	84.6	55.4
Standard deviation	21.5	2.07	93.5	95.2	29.3	50.4	27.0	15.5
Minimum	876.3	18.08	359.6	7.5	11.7	41.5	24.4	16.2
Maximum	939.2	23.06	687	258.5	89.7	198.7	105.7	66.8

[a] Analysis made in the Animal Nutrition Laboratory of the Animal Science Department of UFLA.
[b] Dry matter (DM), gross energy (GE), crude protein (CP), ether extract (EE), crude fiber (CF), neutral detergent fiber (aNDFom), acid detergent fiber (ADFom).

chemistry composition of the feedstuffs (Zhou et al., 2010), the broiler age (Wiseman, 2006) and the methodology utilized to determine the energetic value (Losada et al., 2010).

Several researchers (Rodrigues et al., 2001; Zhao et al., 2008; Nascimento et al., 2009) have obtained prediction equations to estimate the ME using the chemistry composition of the feedstuffs; however, their results have been inconsistent or applicable only to one feedstuff group. Thus, it is necessary to combine information derived from collected data in different conditions to obtain results that are more consistent.

Recently, the use of meta-analyses to obtain prediction equations has shown promising results. A meta-analysis combines the results of several studies that address a set of related research hypotheses, increasing the statistical power of the conclusion (Fagard et al., 1996). Based on this technique, equations to predict the nitrogen-corrected metabolizable energy (AMEn) were developed by Nascimento (2007) and Nascimento et al. (2009) utilizing information gathered by numerous experiments and circumstances involving energetic and protein feedstuffs for broilers.

The objective of this work was to evaluate the proposed equations by Nascimento (2007) and Nascimento et al. (2009) and to estimate the AMEn values of the protein and energetic concentrate feedstuffs used by the poultry feed industry.

2. Materials and methods

2.1. Ingredients

A total of nine protein concentrate ingredients and nine energetic concentrate ingredients were simultaneously obtained from a commercial establishment, considering the availability in Brazil and the chemical variation among the feedstuffs. The protein concentrate ingredients were four samples of commercial trademark soybean meal and one sample each of semi-integral soybean meal, full-fat extruded soybean, texturized soybean protein, integral micronized soy and maize gluten meal. The energetic concentrate ingredients were as follows: samples of two different maize hybrids, two samples of sorghum, and one sample each of broken rice, integral rice meal, pre-gelatinized maize, wheat meal and broken maize.

Feedstuffs samples were analyzed immediately upon collection and the chemical composition is shown in Tables 1 and 2.

2.2. Experimental procedures

The AME values of the feedstuffs were determined *in vivo* using the substitution method. The experiments were approved by the Ethics Committee of the Federal University of Lavras.

Two bioassays were conducted, one with protein concentrate ingredients and another with energetic concentrate ingredients. Experimental diets were manufactured by substituting the protein concentrate ingredients studied for 300 g/kg of a basal diet or the energetic concentrate ingredients for 400 g/kg of the same diet. In both bioassays, each one of the nine dietary treatments was offered to six cages of five male chicks (Cobb 500) that were maintained in metabolic cages from days 15 to 25 post-hatch. Broilers were kept in an environmentally controlled room at a temperature of 24 °C under constant 24-h incandescent lighting, with free access to feed and water.

The basal diet was a maize and soybean meal containing 200 g/kg of crude protein. The estimative of energetic value and digestibility of nutrients of basal diet was 12.52 MJ/kg of ME, 11.3 g/kg of digestible lysine, 82.0 g/kg of digestible methionine plus cysteine, 88.0 g/kg of calcium and 44.0 g/kg of available phosphorus, according to Rostagno et al. (2005).

Total excreta output and feed intake were determined from 23 to 25 days post-hatching (Rodrigues et al., 2005). Daily excreta collections were then pooled within a cage and weighed. Representative excreta samples were retained and frozen.