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The energy value of pig diets estimated *in vitro* and *in vivo*

E. Święch[1] and L. Buraczewska

The Kielanowski Institute of Animal Physiology and Nutrition,
Polish Academy of Sciences
05-110 Jabłonna, Poland

ABSTRACT

The content of digestible (DE) and metabolizable (ME) energy was determined in 29 pig diets by *in vivo* and *in vitro* procedures. Growing, castrated males were used for the *in vivo* balance study. The DE and ME values of diets estimated *in vivo* and *in vitro* were similar. The correlation coefficients for DE and ME were 0.802 and 0.772 , respectively. Predicting the energy value of pig diets with satisfactory precision seems possible using the *in vitro* technique.

KEY WORDS: metabolizable energy, digestible energy, pigs, *in vitro*

INTRODUCTION

Information on the energy values of feedstuffs and diets is needed for efficient diet formulation and prediction of animal performance. The energy value of individual feedstuffs and complete diets can be expressed as the content of digestible (DE), metabolizable (ME) or net (NE) energy. The present feed evaluation system is based on analysed content and determined or tabulated values of nutrient digestibility.

A conventional pig balance study is time consuming and costly. In recent years several different *in vitro* methods have been developed for evaluating energy digestibility in pigs (van der Meer and Perez, 1992; Boisen and Fernández, 1997). Validation of the methods has been attempted by determining the relationship between *in vitro* and *in vivo* results (e.g., Graham et al., 1989; Boisen and Fernández, 1997).

The aim of this study was to compare the energy values (DE and ME) of pig diets estimated in balance experiments and using an *in vitro* method, and to assess the validity of the *in vitro* assay.

[1] Corresponding author: e-mail: e.swiech@ifzz.pan.pl

MATERIAL AND METHODS

Feeds

Twenty-nine diets used in the balance experiments performed the during last three years were evaluated. The diets contained from three to six feed ingredients. The main ingredients of diets were (in parenthesis: number of diets in which the ingredient was included and range of inclusion in g kg^{-1}): maize (26, 126-640), soyabean meal (27, 20-230), wheat (19, 250-770), pea (2, 500), triticale (4, 348-533), full fat soya (26, 40-120), maize gluten (6, 125), yellow lupin (6, 70), rapeseed meal (2, 58-60), casein (16, 20), wheat gluten (2, 27-54) and rye (1, 270). All diets were supplemented with limestone, dicalcium phosphate, salt, vitamin and mineral mixtures, and synthetic amino acids. Diets were formulated to contain amino acids according to the recommendation of Rademacher et al. (1999). The subsamples used in *in vitro* measurements were drawn from frozen reference samples of materials used in balance experiments performed in recent years with pigs.

Methods

The experiment on pigs was carried out on growing castrated males of a body weight range from 20 to 40 kg. The animals were fed equal meals three times daily. After four days of feeding the experimental diets, faeces were collected quantitatively for 6 days. Six pigs were used per diet. The digestible energy content was calculated from the difference between energy intake and energy excreted in faeces. The metabolizable energy content was calculated from DE after correction for protein content in urine (Noblet et al., 1989).

The *in vitro* method developed by Boisen and Fernández (1997) was used for prediction of total digestibility of energy. Total tract digestion was simulated by three consecutive incubations corresponding to digestion in the stomach, the small intestine and the hindgut: with pepsin at pH 2.0 for 2 h, pancreatin at pH 6.8 for 4 h and a multi-enzyme complex (contain a wide range of microbial carbohydrases including arabinase, cellulase, ß-glucanase, hemicellulase, xylanase and pectinase) at pH 4.8 for 18 h at 39ºC. Digestibility of energy was calculated from the digestibility of organic matter using a regression equation. The content of DE and ME was calculated using regression equations.

Dry matter, nitrogen, ether extract, and crude fibre of diets were estimated using standard methods (AOAC, 1990). The gross energy of diets and faeces was determined by a Parr adiabatic oxygen bomb KL-10 caolorimeter.

RESULTS AND DISCUSSION

The chemical composition and energy value of 29 diets is shown in Table 1. The crude protein and ether extract contents were more variable than the content of ash, crude fibre and GE.

In general, the DE and ME contents in diets estimated in pigs and *in vitro* were similar (Table 1). The relationship between the DE and ME contents in diets estimated in pigs and *in vitro* is given in Figures 1 and 2. The correlation coefficients were high (r^2=0.802 and 0.772, respectively). This is in agreement with results obtained by Boisen and Fernández (1997) who found a high correlation between total energy digestibility in pigs and organic matter digestibility *in vitro*

Table 1. Chemical composition (g kg^{-1} DM) and energy value (cal g^{-1} DM) of diets for pigs

	Mean	Minimum	Maximum
Crude protein	211	160	239
Ash	51	47	56
Ether extract	39	15	51
Crude fibre	32	28	48
GE[1]	4848	4540	5012
DE_{pig}[2]	4143	3727	4434
$DE_{in\ vitro}$[2]	4129	3772	4302
ME_{pig}[3]	3981	3598	4250
$ME_{in\ vitro}$[3]	3968	3641	4124

[1] gross energy, [2] digestible energy estimated in pigs or *in vitro*, [3] metabolizable energy estimated in pigs or *in vitro*

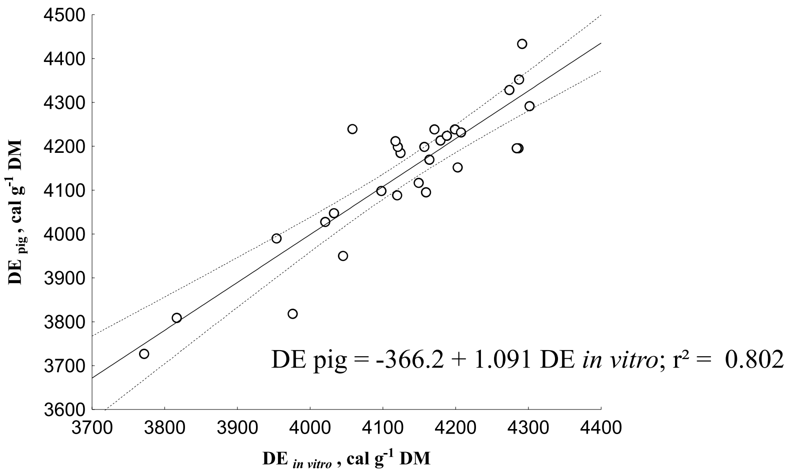

Figure 1. Relationship between the digestible energy content of 29 diets estimated on pigs (DE_{pig}) and *in vitro* ($DE_{in\ vitro}$)

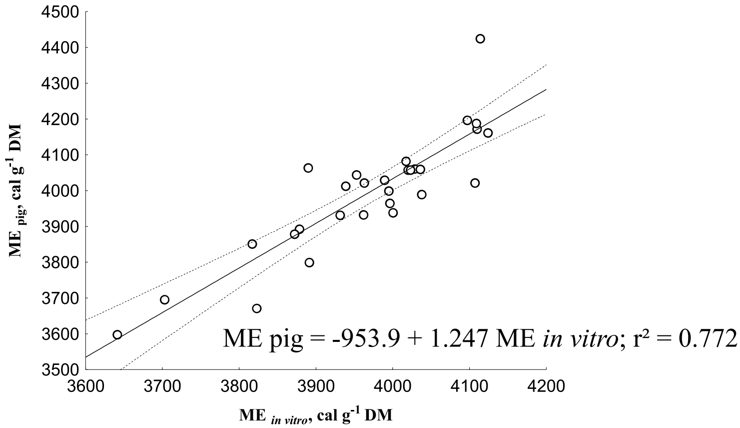

Figure 2. Relationship between the metabolizable energy content of 29 diets estimated on pigs (ME_{pig}) and *in vitro* ($ME_{in\ vitro}$)

in 31 feedstuffs (r^2=0.94) and between total energy digestibility in pigs and predicted *in vitro* energy digestibility in 34 diets (r^2=0.87). A close relationship (r^2=0.84) between organic matter digestibility determined in pigs and *in vitro* using a similar *in vitro* method was also found by van der Meer and Perez (1992) in 89 diets.

CONCLUSIONS

It seems possible to predict the energy value of pig diets with satisfactory precision using an *in vitro* technique.

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