Development of *In vitro* Technique for Bioavailable Corn Energy Value

I. B. Kim*

Department of Animal Sciences, University of Missouri-Columbia, Columbia, MO 65211, USA

ABSTRACT : The objective of this study was to develop an *in vitro* digestion technique to estimate bioavailable energy values of different corn hybrids in swine and poultry. A total of 21 samples were investigated; 18 normal corn (NC) and 3 high-oil corn (HOC) hybrids. One step-two enzymes digestion system was introduced to develop the *in vitro* technique. The gross energy (GE) values of NC hybrids were correlated with the *in vitro* disappearing energy values (IVE; r=0.85, $p<0.01$), the *in vitro* energy digestibilities (IVED; r=0.70, $p<0.01$), and the *in vitro* DM digestibilities (IVDM; r=0.55, $p<0.05$). It appears, however, that IVE values of NC and HOC hybrids were not significantly different according to the one step-two enzyme digestion system. Results of *in vivo* and *in vitro* estimates suggested that there was no significant correlation between them in poultry. The IVE value was regressed linearly with ME and DE values in swine with low regression coefficient (34 and 41%, respectively). ***(Asian-Aust. J. Anim. Sci. 2001. Vol 14, No. 11 : 1645-1646)***

Key Words : *In vitro* Technique, Corn Energy, Pig, Poultry

INTRODUCTION

Estimating nutrient digestibility of feed ingredients by conventional *in vivo* methods requires lots of feeds, animals, considerable expenditure of equipment and manpower. Several *in vitro* techniques have been proposed over the last two decades (Furuya et al., 1979; Vervaeke et al., 1989; Boisen and Eggum, 1991; Van der Meer and Perez, 1992). Among of them the one was originally developed in Denmark (Boisen, 1991) has recently been updated and, after verification of its accuracy, definitively adopted for the practical evaluation of mixed diets for pigs (Boisen and Fernandez, 1997; Spanghero and Volpelli, 1999). Due to the high inclusion in feed, the various energy values of corn could lead to the economical and nutritional losses. But there is little research for advancing *in vitro* technique to evaluate the energy values of corn, and to compare *in vitro* with *in vivo* results. Consequently the objective of the present study was to develop an *in vitro* digestion technique to estimate bioavailable energy values of different hybrids of corn.

MATERIALS AND METHODS

A total of 21 samples were examined; 18 normal corn (NC) and 3 high-oil corn (HOC) hybrids. These corn samples were derived from multiple genetic lines, grown in different locations past five years. Therefore, it was not available to separate the genetic and environmental factors upon nutritive values of corn hybrids. *In vitro* technique developed in the author's lab was modified from Boisen and Fernández's method (1997) to estimate the energy values of corn. A single step digestion with two enzyme technique was applied; a pancreatin solution (Porcin panceatin; Sigma P7545, 10 mg/ml) and a heat-stable α-amylase solution (ANKOM Tech. Corp., 340,000 MWU/ml), and then digested products filtered by Whatman® paper (#541, 9.0 cm, Cat No. 1541 090). All corn samples were ground using a CycloTek® (Tecater model, Fisher Scientific Ltd.) through a 1 mm screen and analyzed for DM and proximate analysis (AOAC, 1995). The energy content was determined by the oxygen bomb calorimeter (Model 1341 Oxygen Bomb Calorimeter, Parr® Instrument Co.). The energy value and DM digestibility of corn were calculated by subtraction of filter paper's energy and DM (blank tests). This assay procedure is illustrated in detail on figure 1. Within NC hybrids, results of *in vitro* digestion for energy value were statistically analyzed using a GLM procedure of SAS (1992) in swine (DE and ME) and poultry (TMEn and AME) (Kim, 1999).

RESULTS AND DISCUSSION

The average energy value disappearing *in vitro* of NC hybrids (IVE; 3,574 cal/g) using the present technique represented about 80.1% of the corn gross energy (GE; 4,465 cal/g). The GE values of NC hybrids were correlated with the IVE values (r= 0.85, $p<0.01$), the *in vitro* energy digestibilities (IVED; r=0.70, $p<0.01$), and the *in vitro* DM digestibilities (IVDM; r=0.55, $p<0.05$). It appears, however, that IVE values of NC and HOC hybrids were not significantly different each other according to the one step-two enzyme system. Since the HOC has the higher oil, protein, and fiber contents than those of NC hybrids,

* Corresponding Author: I. B. Kim. Campus Box 7621, Department of Animal Science, North Carolina State University, Raleigh, NC 27695-7621, USA. Tel: +1-919-515-4045, Fax: +1-919-515-7780, E-mail: inbaekim@rocketmail.com

Received April 28, 2001; Accepted June 13, 2001

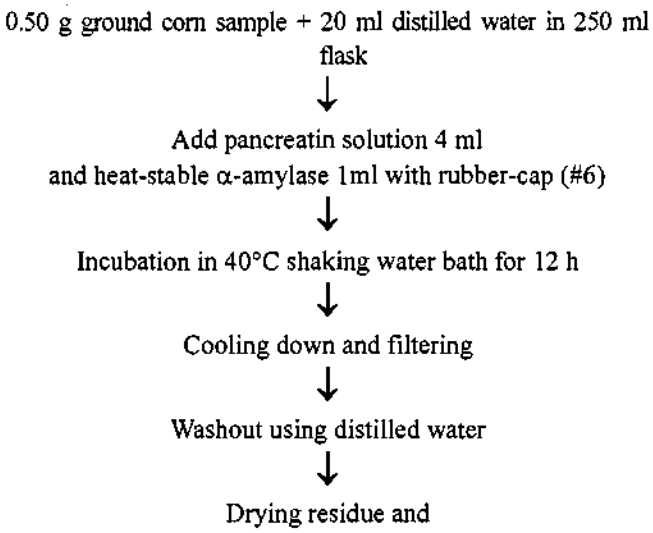

Figure 1. *In vitro* technique to estimate the bioavailable energy value of corn

furthermore, the present *in vitro* technique did not include the enzyme complexes required to liberate the energy from protein and fat in corn. Therefore, it should be reported that the technique suggested here could not estimate the *in vitro* energy values appropriately in case of HOC hybrids. It would be due to the less sensitivity of filtration system. Several correlated relationships were found among *in vitro* and *in vivo* results (table 1). But the *in vitro* results did not have significant relationships *in vivo* results in poultry. The reasons were not clear. The IVE value was regressed linearly with the ME and the DE values in swine, with low regression coefficient. These regression equations of prediction could be suggested as follows;

ME (cal/g DM)=0.19×IVE (cal/g DM)+3,137.7
[R^2=0.34, p<0.05, C.V.=1.06]

DE (cal/g DM)=0.21×IVE (cal/g DM)+3,129.0
[R^2=0.41, P<0.01, C.V. = 1.03]

It seems that the present *in vitro* technique could not be reliable completely, in part, due to the filtration system because the oil or fat in grain might attach to the fiber of filter paper. Therefore, IVE values couldn't represent the *in vivo* results precisely. It would be the reason for no differences between NC and HOC hybrids.

Table 1. Correlation relationship among the *in vitro* and *in vivo* results in NC hybrids[1,2]

Items	IVE	IVED	IVDM
ME (kcal/kg DM)	0.58	0.54	-
	(0.01)	(0.02)	
DE (kcal/kg DM)	0.64	0.58	0.50
	(0.01)	(0.01)	(0.03)
DM Digestibility of Swine (%)	-	-	0.50
			(0.03)
DM Digestibility of Rooster (%)	-0.61	-0.52	-
	(0.01)	(0.03)	

[1] Abbreviations: IVE, *In Vitro* Disappear Energy (cal/g DM); IVED, *In Vitro* Energy Digestibility (% DM); IVDM. *In Vitro* DM Digestibility (%).

[2] Table contents are expressed correlation coefficient (*r*) and P value.

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