Interest of *in vitro* pre-digestion to estimate fermentescibility of feedstuffs in pig large intestine

C. Boudry[1], F. Estrada[2], O. Schoeling[1], E. Froidmont[3], J. Wavreille[3], A. Buldgen[1]

[1] Laboratory of Animal Husbandry,
Agricultural University , Passage des déportés 2, 5030 Gembloux, Belgium
[2] National University of Colombia, campus of Palmira
Carrera 32, Palmira, Colombia
[3] Ministry of Walloon Region, Agricultural Research Centre. Department of Animal Production and Nutrition, Rue de Liroux 8, 5030 Gembloux, Belgium

The aim of this study was to compare ileal and faecal digestibilities to gas production in syringes, preceded or not by an *in vitro* enzymatic digestion of two pig diets containing different amounts of non starch polysaccharides (NSP). *In vivo,* only nitrogen faecal digestibility differed between the two diets. Their enzymatic pre-digestion led to a higher gas production after 16 h of incubation in syringes for the diet with the lowest N faecel digestibility but not without pre-digestion. We may conclude that an *in vitro* pre-digestion before incubation in syringes is necessary to evaluate feed fermentescibility in pig large intestine.

Introduction

Nowadays the pig industry have to cope with pathological, economical and environmental problems. The incorporation of fibrous resources, like forages and several industrial by-products, in pig diets may partially solve such problems. They are cheap and their consumption by pigs reduces the pH of slurry by production of volatile fatty acids (VFA), decreasing ammonia emission and odours (Sutton *et al.*, 1999). Carbohydrate fermentation may also shift the N excretion in faeces, in the form of bacterial protein (Canh *et al.*, 1998). Moreover, the production of VFA in the large intestine prevent diarrhoea by lowering intestinal pH and increasing electrolyte and fluid absorption (Bird *et al.*, 2000; Williams *et al.*, 2000).

However, little is known about fibre fermentescibility in the large intestine of pigs and simple methods devoted to this parameter are lacking. The aim of this study was to compare the *in vivo* digestibility of two diets with their fermentescibility in syringes, with or without an *in vitro* pre-digestion.

Materials and methods

Two well balanced pig diets based on wheat (65%), soybean meal (13%) and wheat bran (5%) for the first one (Soya Diet, SD) and wheat (65%), lupin seeds (18%) and soybean meal (2%) for the second one (Lupin Diet, LD) were used in this study. The DM (Dry Matter), OM (Organic Matter) and N ileal and faecal digestibilities of each diet were established on 4 growing pigs (*Landrace X Pietrain*, $\pm$ 40 kg LW) fitted with a PVTC cannula and housed in metabolic cages (Froidmont *et al.,* 2003).

Milled samples (n = 32) of the two diets (1 mm sieve), were digested *in vitro* according to an enzymatic method (pepsin and pancreatin) adapted from Boisen and Fernandez (1997). The third step of this method was modified and limited to the filtration (without addition of Celite) and washings. Moreover, the residues were dried at 60℃ until constant weight.
The diets were tested, with and without *in vitro* pre-digestion, for their fermentescibility in syringes (n = 9), according to a method adapted from Menke and Steingass (1988). Faeces collected from two pigs (*Landrace x Pietrain*, ± 50 kg LW) fed a commercial diet without antibiotics were used as *inoculum*. They were diluted in the buffer medium from Menke and Steingass (1988) (ratio faeces/buffer 1 : 10) and incubations in syringes were achieved over 72 h.
The digestibility values and the gas productions of the two diets were compared by analyses of variance.

Results

In the *in vivo* trials, only N faecal digestibility values of the two diets were significantly different, with a lower value for LD ($P < 0.05$). The *in vitro* DM digestibilities of the two diets were closed but significantly different ($P < 0.05$). Complete results are presented in Table 1. Table 1
Gas productions in syringes of SD and LD samples were not significantly different after the 72 h incubation ($P > 0.05$). *In vitro* pre-digestion of those two diets samples decreased the gas productions and led to a higher gas production with pre-digested LD samples in comparison with pre-digested SD samples ($P < 0.05$) from 16 h until the end of incubation. The gas productions are described in figure 1. Figure 1

Discussion

The higher gas production for LD after the *in vitro* pre-digestion reflects a higher microbial activity and may explain its lower *in vivo* N faecal digestibility. The increased microbial activity may be due to the greater content of NSP in lupin seeds compared to soybean meal (405 g NSP kg^{-1} in lupin *vs* 180 g NSP kg^{-1} in soya; Bach Knudsen, 1997) which are resistant to the action of endogenous enzymes, but sensitive to bacterial enzymes. The gas productions recorded with and without *in vitro* pre-digestion for each diet shows that *in vitro* pepsin-pancreatin pre-digestion is necessary to characterise the fermentescibility of feedstuffs in the large intestine of pigs, especially when they are rich in NSP.

References

Bach Knudsen, EK (1997) Carbohydrate and lignin contents of plant materials used in animal feeding. Animal Feed Science and Technology 67, 319-338.

Bird, AR, Hayakawa, T, Marsono, Y, Gooden, JM, Record, IR, Correll, RL ans Topping, DL (2000) Coarse brown rice increases fecal and large bowel short chain fatty acids and starch but lowers calcium in the large bowel of pigs. Journal of Nutrition 130, 1780-1787.

Boisen, S and Fernandez, JA (1997) Prediction of the total tract digestibility of energy in feedstuffs and pig diets by *in vitro* analyses. Animal Feed Science and Technology 68, 277-286.

Canh, TT, Sutton, AL, Aarnink, AJA, Verstegen, MWA, Schrama, JW And Bakker, GCM (1998) Dietary carbohydrates alter the faecal composition and pH and the ammonia emission from slurry of growing pigs. Journal of Animal Science 76, 1887-1895.

Froidmont, E, Schoeling, O, Deliège, F, Wathelet, B, Wavreille, J and Bartiaux-Thill, N (2003) Influence de la substitution du tourteau de soja par des graines de lupin, avec ou sans complément d'α-galactosidase, sur la digestibilité des régimes et la rétention azotée du porc en croisssance. *Journées de la recherche porcine en France*, 35, 105-112.

Menke, KH and Steingass, H (1988) Estimation of the energetic feed value obtained from chemical analyses and *in vitro* gas production using rumen fluid. Animal Research and Development 28, 7-55.

Sutton, AL, Kephart, KB, Verstegen, MWA, Canh, TT and Hobbs, PJ (1999) Potential for reduction of odorous compounds in swine manure through diet modification. Journal of Animal Science 77, 430-439.

Williams, BA, Tamminga, S and Verstegen, MWA (2000) Fermentation kinetics to assess microbial activity of gastrointestinal microflora. In : Proceedings of the Symposium on Gas Production : fermentation kinetics for feed evaluation and to assess microbial activity. Wageningen, Netherlands, p 97-100.

Table 1. *In vitro* (n = 32) and *in vivo* (n = 4) digestibility values of soya (SD) and lupin (LD)diets.

	Soya Diet (SD)			**Lupin Diet (LD)**		
	DM	OM	N	DM	OM	N
In vitro digestibility (%)	84.7[a]			83.4[b]		
Ileal digestibility (%)	62.2[a]	68.1[a]	72.4[a]	62.8[a]	68.5[a]	74.6[a]
Faecal digestibility (%)	87.0[a]	89.2[a]	90.3[a]	86.9[a]	88.5[a]	86.9[b]

[ab] In the row, digestibilities of chemical compounds with different subscripts are significantly different ($P < 0.05$)

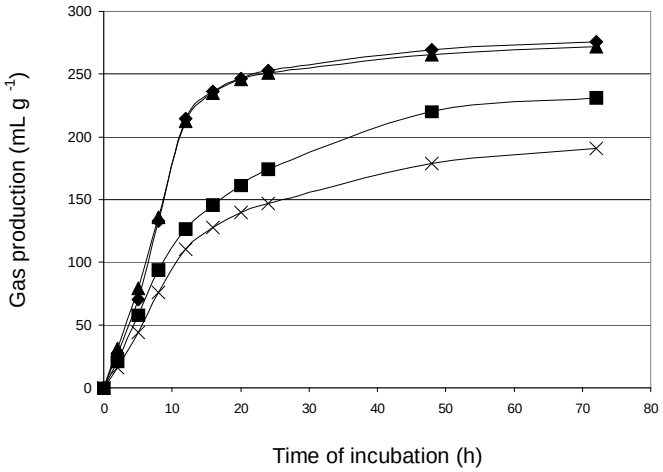

Figure 1. Gas production of soya (SD) and lupin (LD) diets with and without enzymatic pre-digestion (n = 9) (–▲– SD; –♦– LD ; –x– SD pre-digested; –■– LD pre-digested)