BELGIAN COUNCIL FOR LABORATORY ANIMAL SCIENCE (VZW / ASBL)

XXXIVth BCLAS symposium, Katholieke Hogeschool der Kempen, Geel, November 15th, 2007

BCLAS W-G
The Working Group for Biotechnicians and Animal Caretakers

A method combining enzymatic hydrolysis and *in vitro* fermentation to avoid *in vivo* trials to determine the nutritional value of forages and diets fed to Guinea pigs raised for meat production

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Introduction

Guinea pigs (GP) are raised for meat production in the Andean countries and in Sub-Saharan Africa (Hardouin et al., 1991) but their actual contribution to food security is greatly ignored (Picture 1).

In Africa, GP production systems have low productivities because of inefficient management and feeding practises.

Improving the feeding systems requires, as a first step, to determine the nutritive value of a wide range of resources available around the farms.

The *in vivo* method using GP in metabolic crates is the reference but it is time-consuming, expensive and stressful for the animals.

This study aimed to validate an alternative method for the rapidly screening of the nutritional value of a wide range of resources.

Pictures 1 a and b. GP production in a backyard in Kinshasa (DRC).

Materials and Methods

11 ingredients :

5 fresh tropical forages (grasses and dicots)

6 mixed hay-concentrate diets

Reference method

In vivo digestibility trials (Picture 2):

GP in metabolic crates (3 per ingredient)

measurement of ingestion and collection of faeces for 4 days × 3 periods

calculation of digestibility coefficients : dry matter (dDM), organic matter (dMO), crude protein (dCP) and energy (dE).

Picture 2. GP in a metabolic crate (Kinshasa, DRC).

Alternative method

In vitro simulation of digestion in the stomach and in the small intestine enzymatic hydrolysis and fermentation in the large intestine (Figure 1 and Picture 3):

pepsin and pancreatin hydrolysis (Boisen and Fernández, 1997)

gas fermentation test with an inoculum prepared from GP faeces (Bindelle et al., 2007)

calculation of dry matter (HDM) and crude protein (HCP) disappearance during enzymatic hydrolysis and gas production kinetics during fermentation of the residues: final gas production (G_f, ml/gDM), lag time (L, h), time to half gas production (T/2, h), fractional rate of degradation ($\mu_{t=t/2}$, h^{-1}) (Figure 2).

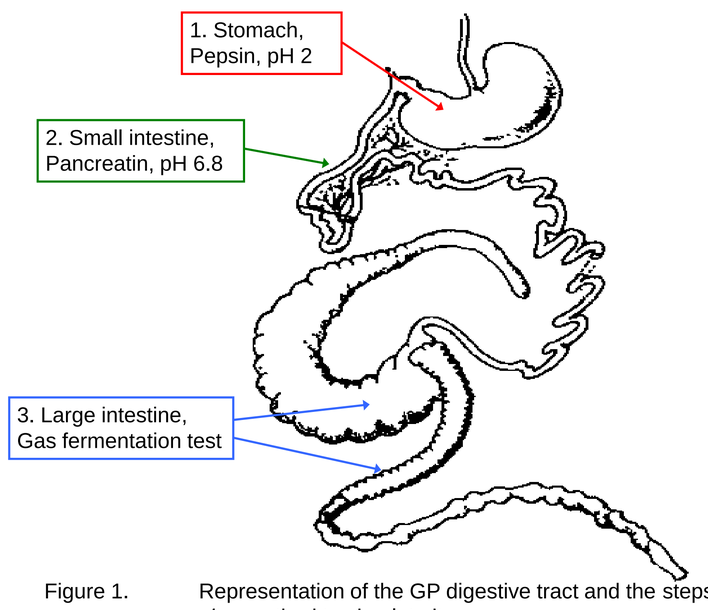

Figure 1. Representation of the GP digestive tract and the steps of the *in vitro* method to simulate it.

Comparison

Pearson's correlation coefficients and simple or multiple linear regressions

Picture 3. Syringes used for the gas fermentation test.

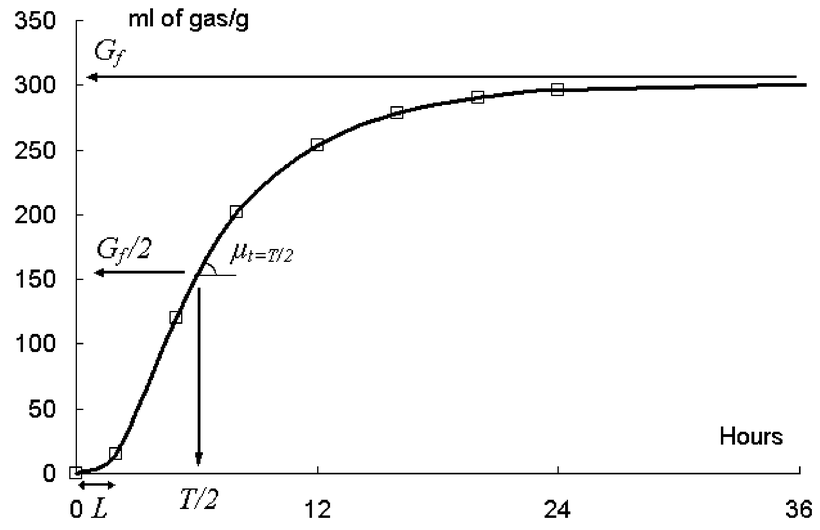

Figure 2. Representation of the kinetics parameters of the gas production curves modeled according to France et al. (1993).

Results

As shown in Table 1 and on Figure 3, parameters from the enzymatic hydrolysis were positively correlated to all *in vivo* digestibility coefficients.

Fast fermenting ingredients (low L and T/2) showed higher in vivo dDM and dMO and dE ($P<0.05$). Final gas production were positively correlated to dDM and dMO. None of the gas fermentation parameters was correlated to *in vivo* dCP.

Table 1. Pearson's correlation coefficients between in vivo digestibility coefficients and in vitro enzymatic hydrolysis and fermentation parameters.

In vitro parameters		*In vivo* digestibility coefficients			
		dDM	dMO	dN	dE
Pepsin-pancreatin hydrolysis	HDM	**0.748**^{**1}	**0.714***	**0,659***	0.543†
	HCP	-0,110^{NS}	-0,105^{NS}	**0,601***	0.482^{NS}
Fermentation gas production kinetics	G_f (ml/g DM)	**0,926*****	**0,940*****	0,371^{NS}	-0.011^{NS}
	L (h)	-0,521^{NS}	-0,492^{NS}	-0,496^{NS}	-0.648*
	T/2 (h)	**-0,746****	**-0,749****	-0,412^{NS}	0.170^{NS}
	$\mu_{t=T/2}$ (h^{-1})	0,460^{NS}	0,473^{NS}	0,245^{NS}	-0.400^{NS}

[1] ***, P<0.001; **, P<0.01; *, P<0.05; †, P<0.10; NS, not significant

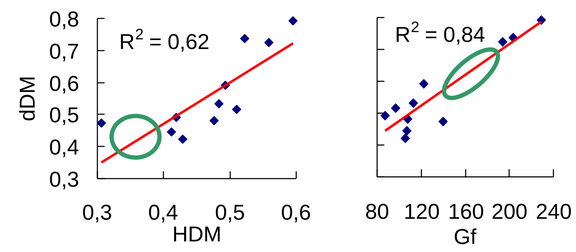

Figure 3. Regression between *in vivo* dry matter digestibility (dDM) and dry matter disappearance during *in vitro* enzymatic hydrolysis (HDM) and final gas production (Gf, ml g^{-1}).

Multiple parameters linear equations were calculated to predict in vivo digestibility coefficients from the alternative method:

$dDM = 0.0196 + 0.621 \times HDM + 0.00183 \times Gf$ ($R^2 = 0.92$, $P<0.001$, $S = 0.0355$)

$dMO = 0.0383 + 0.552 \times HDM + 0.00200 \times Gf$ ($R^2 = 0.92$, $P<0.001$, $S = 0.0367$)

$dE = 0.104 + 0.778 \times HDM + 0.00649 \times Gf$ ($R^2 = 0.55$, $P<0.05$, $S = 0.0431$)

Conclusion

The determination of the nutritive value of unknown resources for feeding the Guinea pigs can be achieved successfully by means of the in vitro method.

The database should be enlarge to other ingredients in order to strengthen the predicting equations since in the range of variation of the *in vivo* and *in vitro* parameters some gaps are observed as highlighted on figure 3 by the green circles (○).

References

Bindelle J., Ilunga Y., Delacollette M., Muland Kayij M., Umba di M'Balu J., Kindele E., Buldgen A. 2007. Voluntary intake, chemical composition and in vitro digestibility of fresh forages fed to Guinea pigs in periurban rearing systems of Kinshasa (Democratic Republic of Congo). Trop. Anim. Health Prod. 39, 419-426.

Boisen S., Fernández J.A. 1997. Prediction of the total tract digestibility of energy in substrates and pigs diets by in vitro analyses. Anim. Feed Sci. Technol. 68, 277-286.

France J., Dhanoa M.S., M.K. Theodorou M.K., Lister S.J., Davies D.R., Isac D. 1993. A model to interpret gas accumulation profiles associated with in vitro degradation of ruminant feeds, J. Theor. Biol. 163, 99–111.

Hardouin J., Demey F., Fransolet M.F. 1991. Le cobaye Cavia porcellus L., animal de boucherie en pays tropicaux. Ann. Gembloux. 97, 69-80.