

Apparent digestibility in meat-type guinea pigs as determined by total collection or by internal marker

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ABSTRACT: Six adult male meat-type guinea pigs were subjected to three subsequent digestibility trials with 100% alfalfa, 50% alfalfa and 50% sugar cane and 50% alfalfa and 50% concentrate. For each animal in each period, feed intakes were recorded and all faeces were collected and stored at –20°C until analysis. Feeds and faeces were analysed for dry matter, crude ash, crude protein, ether-extract, crude fibre and acid-insoluble ash. Coefficients of apparent digestibility were calculated according to both the total collection method and the marker method with acid-insoluble ash as internal marker. The present study suggests that acid-insoluble ash is not valid as an internal marker when looking at differences between individuals, but might be useful to demonstrate differences between diets, albeit with lack of accuracy for estimating the absolute digestibility coefficients obtained through the total collection method. Sugar cane was slightly less digestible than alfalfa in meat-type guinea-pigs.

Keywords: guinea pigs; markers; digestion; feedstuffs

In many countries in South-America (e.g. Bolivia: Paterson et al., 2001; Ecuador: Lawrence, 1997) and Africa, Cameroon (Manjeli et al., 1998), guinea pigs are considered as a valuable animal protein source. Yet, the local production of guinea pig meat is prone to many nutritional imbalances. Their diet is often composed on a rather empirical basis because of lack of proper data on the feeding value of the local feedstuffs for guinea pigs in these countries. Guinea pigs have been extensively used as laboratory animals in a way that the word “guinea pig” has become synonym for animals or persons that are submitted to tests. Yet, data on general nutritional demands in practice are rather scarce. Moreover, the type of guinea pigs used for consumption differs from their experimental or pet counterparts (Spotorno et al., 2006), and nutritional requirements obtained in laboratory-type or pet-type guinea pigs are thus difficult to extrapolate to meat-type guinea pigs. In Ecuador and other countries, these animals are fed several locally grown feedstuffs with unknown nutritional value to the guinea pig.

Nutrient analysis is the first step in gathering knowledge on the feeding value of these feedstuffs, but their digestibility in guinea pigs is another crucial determinant.

The common way to perform digestibility trials is to collect all feed consumed and all faeces excreted during a certain number of days, which requires the use of specific metabolism cages.

Using an internal marker for estimating apparent digestibility coefficients has a number of advantages in comparison to the total collection method (Sales and Janssens, 2003a).

Therefore, this trial was set up to investigate the potential of acid-insoluble ash (AIA) as an internal marker for measuring apparent digestibility in meat-type guinea pigs.

MATERIAL AND METHODS

The trial was performed at the ESPOCH at an altitude of 2 750 m. Six male guinea pigs (*Cavia*

porcellus) were used in three subsequent digestibility trials. The type of guinea pig was the “macabeo”, an Ecuadorian meat-type guinea pig. Their average body weight was 320 g. They were housed individually in plastic crates measuring 56.5 cm long, 37 cm wide and 30 cm high, with a grid size of 2 × 2 cm. This type of housing allowed the guinea pigs to perform normal caecotrophy. All crates were placed in a row with 20 cm in between. Hence, all animals were able to have visual contact with each other. The crates were put on a moderate slope in order to improve faeces collection.

In the first trial, alfalfa hay was used as sole dietary component. During the second trial, the animals were fed a mixture of 50% alfalfa and 50% sugarcane (w:w). In the third trial, a mixture of 50% alfalfa and 50% concentrates (w:w) was tested. It was decided not to feed sugarcane or concentrates as sole ingredient because of the danger for bloat.

Each trial consisted of an adaptation period of six days, followed by a collection period of six days, during which all excreta were collected and all feed consumed was measured by subtracting the remainders from the offered quantity.

All feedstuffs and faeces samples were subject to proximate analysis (dry matter, crude ash, crude protein, ether-extract, crude fibre) according to the AOAC guidelines (AOAC, 1980) and AIA according to Van Keulen and Young (1977). Their composition is presented in Table 1.

Coefficients of apparent digestibility for dry matter, organic matter, crude protein, crude ash, ether-extract, crude fibre and nitrogen-free extract were calculated following the total collection (TC) method:

$$AD_{\text{nutrient}} = 100 (Q_{\text{feed}} \times N_{\text{feed}} - Q_{\text{faeces}} \times N_{\text{faeces}}) / Q_{\text{feed}} \times N_{\text{feed}}$$

where:

AD_{nutrient} = the apparent digestibility coefficient of the nutrient (%)

Q_{feed} = the quantity of ingested feed (g)

N_{feed} = the dietary concentration of the nutrient (%)

Q_{faeces} = the quantity of faeces produced (g)

N_{faeces} = the faecal concentration of the nutrient (%)

and following the internal marker (IM) method:

$$AD_{\text{nutrient}} = 100 - 100 (M_{\text{feed}} \times N_{\text{faeces}}) / (M_{\text{faeces}} \times N_{\text{feed}})$$

where:

AD_{nutrient} = the apparent digestibility coefficient of the nutrient (%)

M_{feed} = the dietary concentration of the marker (%)

N_{feed} = the dietary concentration of the nutrient (%)

M_{faeces} = the faecal concentration of the marker (%)

N_{faeces} = the faecal concentration of the nutrient (%)

Repeated measures analysis was performed with SPSS 12.0 (SPSS Inc., Chicago, Illinois, USA), with the animal being the within-subject variable and the tested feed being the between-subject variable.

RESULTS

Table 2 shows the apparent digestibility coefficients of the three tested diets, calculated by either the total collection method or by the internal marker method. Standard deviation was acceptable for both methods though large for nutrients at low levels (e.g. ether-extract). Large differences were seen between the means of the two methods, and these differences were not similar for all nutrients. Means obtained by the internal marker method

Table 1. Nutrient composition (g/kg) of the experimental feedstuffs

	Alfalfa	Sugarcane	Concentrate
Dry matter	27.03	25.59	65.35
Crude ash	3.16	1.68	6.68
Crude protein	7.30	3.79	14.74
Ether-extract	1.12	0.72	2.71
Crude fibre	3.74	3.25	8.54
Nitrogen-free extract	11.71	16.13	32.68
Acid-insoluble ash	0.56	0.43	1.19

Table 2. Nutrient digestibility coefficients (%) of feedstuffs in meat-type guinea pigs, calculated through either total collection (TC) or acid-insoluble ash as internal marker (AIA)

	Alfalfa		Alfalfa and concentrate		Alfalfa and sugarcane		Significance
	TC	AIA	TC	AIA	TC	AIA	
Dry matter	76 ± 6	40 ± 9	83 ± 2	61 ± 3	73 ± 8	20 ± 10	F, M, F × M
Crude ash	76 ± 9	63 ± 4	81 ± 3	56 ± 3	64 ± 14	51 ± 6	F, M, F × M
Crude protein	86 ± 4	78 ± 1	89 ± 1	75 ± 2	80 ± 5	72 ± 1	F, M, F × M
Ether-extract	56 ± 13	31 ± 9	79 ± 4	52 ± 7	49 ± 20	29 ± 15	F, M
Crude fibre	33 ± 16	–6 ± 5	64 ± 4	18 ± 5	33 ± 17	5 ± 5	F, M, (F × M)
Nitrogen-free extract	85 ± 2	76 ± 2	87 ± 1	70 ± 2	83 ± 5	76 ± 2	M, F × M
Organic matter	76 ± 5	62 ± 1	83 ± 1	63 ± 0	74 ± 7	63 ± 1	F, M, F × M
Acid-insoluble ash	76 ± 6	–	83 ± 2	–	73 ± 8	–	F

TC = total collection method; AIA = internal marker method with acid-insoluble ash; F = feed effect at $P < 0.05$; M = method effect at $P < 0.05$; F × M = feed × method interaction at $P < 0.05$; (F × M) = feed × method interaction at $0.10 < P < 0.05$

were significantly lower compared to the means from the total collection method.

The total collection method showed that sugarcane had reduced digestibility of all nutrients when compared to alfalfa, whereas the concentrate had – as expected – higher digestibility coefficients. This tendency was also present for the internal marker method data, but less clear.

DISCUSSION

The apparent digestibility coefficients for alfalfa as obtained with the total collection method agreed fairly well with Sakaguchi et al. (1997), which implies that the difference between the total collection data and the marker data are most likely due to weak feasibility of acid-insoluble ash as an internal marker in this type of studies.

The success of using AIA as an internal marker is highly variable between studies and species, as shown in the review by Sales and Janssens (2003a). The lack of fitness of AIA as internal digestibility marker in the present study will mainly be attributable to errors in determining the AIA level in the feedstuffs. Deviations for this determination will evoke a crowbar effect on the deviation from the absolute digestibility coefficients. Obtaining a representative sample for this quantification is not the only problem, but especially in roughages, concentrations of AIA can be quite heterogeneously spread, making it very difficult to get a proper esti-

mation of the dietary AIA concentration. In horses, the use of AIA as internal marker in roughages has been demonstrated successful (Peiretti et al., 2006), but in comparison to horses, guinea pigs only ingest small amounts of roughage, enhancing the risk of AIA quantification errors. In small species like parrots and pigeons, the use of AIA as internal marker was successful as long as a homogenous diet was used, but failed when mixtures of whole feedstuffs were used (Sales and Janssens, 2003b; Sales et al., 2004). This hypothesis on the importance of animal size and feed matrix homogeneity is supported by the fact that, numerically seen, the standard deviations when including concentrate in the diet were smallest in our study.

Because the use of internal markers for determining apparent digestibility of feedstuffs would still signify a great advantage for the ease of experimentation and animal welfare, studies with other internal markers would be relevant, e.g. chromic oxide, *n*-alkanes, manganese or crude ash. The latter has been shown a valuable internal marker in adult, non-producing granivorous birds (Sales and Janssens, 2006), but has not been tested in mammals to our knowledge.

CONCLUSIONS

The use of AIA as an internal marker for determining apparent digestibility coefficients in meat-type guinea pigs could demonstrate differences

between feedstuffs, but with less accuracy and precision than with the total collection method.

Acknowledgements

Thanks to Herman De Rycke and the technical staff at the ESPOCH.

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Received: 2008–01–16

Accepted after corrections: 2008–03–06

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