Available online at www.sciencedirect.com
ScienceDirect
Animal Feed Science and Technology
147 (2008) 310–325
ANIMAL FEED SCIENCE AND TECHNOLOGY
www.elsevier.com/locate/anifeedsci

Comparison of gas accumulation profiles of several feeds using manual or automated gas production methods

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Received 13 June 2007; received in revised form 31 January 2008; accepted 13 February 2008

Abstract

The relationship of metabolizable energy (ME) content of the diet to gas production measured by the Hohenheim gas test (HGT) has been studied intensively. However, the HGT is being replaced by automatic systems like the automated pressure evaluation system (APES) and comparison with the HGT method is required before ME estimation can be automated. This study compared the two different gas production methods (HGT and the APES) with regard to the cumulative gas profile. With the APES method, the release of gas may occur at any time, assuming fixed amounts of gas being released for each venting, after reaching fixed values of pressure. With the HGT method manual readings are performed at defined time points. For comparison purposes, gas production was calculated on the basis of ml/200 mg dry matter (DM), as usual in the HGT method. For 11 feeds analyzed (grass silage, meadow hay, fresh red clover, fresh birdsfoot trefoil, whole-crop oat silage, maize stover and ear maize, dairy compound feed and soybean meal) the APES method produced on average 5.5 ml (range 1.1–8.3 ml/200 mg DM) less gas on average compared to the HGT method (0–120 h incubation time). Reasons for the differences may be related to the measurement conditions of each method itself.

Abbreviations: APES, automated pressure evaluation system; DM, dry matter; HGT, Hohenheim gas test; ME, metabolizable energy; OM, organic matter; WCS, whole-crop silage; GP, gas production; CP, crude protein; EE, ether extract (crude fat); TA, total ash.

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0377-8401/$ – see front matter
doi:10.1016/j.anifeedsci.2008.02.001

The ratio of sample size to rumen fluid (mg/ml) is 20:1 in the HGT method and 100:1 in the APES method, which may have influenced the colonization rate and contributed to a larger lag phase in APES. The estimates are based on two runs, which were performed on different days, with the APES method generating a large run effect. In conclusion, the amount of gas produced using the APES method deviated consistently from the amounts of gas produced by the HGT method in a large range of gas production (30–72 ml/200 mg DM). Using the laboratory protocol as proposed by each method, the suggested mathematical correction of the gas measured through APES appears applicable for gas production after 24 h, needing a larger number of samples to prove its efficacy.

Keywords: Feed digestibility; Rumen; Gas production; Nonparametric regression model; *In vitro* techniques

1. Introduction

Several methods were developed to measure rumen *in vitro* gas production in the last decades. One of the more widely used and strictly standardized methods is the Hohenheim gas test (HGT; Menke et al., 1979), which makes use of graduated glass syringes, measuring the gas produced at fixed times. The gas produced after 24 h incubation together with chemical analysis of the feed are then used to estimate the metabolizable energy (ME) contents of feeds for ruminants. The application of the method for ME estimation has been used to evaluate large numbers of feeds and is documented in several studies (*e.g.*, Menke and Steingass, 1988; Rodehutscord et al., 1994; Krishnamoorthy et al., 1995; Getachew et al., 2002, 2004). In order to simplify the method, automatic steps for the measurement of gas produced over time were introduced (Cone et al., 1996; Davies et al., 2000). In these methods, bottles are fitted to a pressure sensor and during fermentation a pressure sensitive switch releases known amounts of the accumulated gas for each bottle, recording in seconds from incubation start the time when valve opens for venting.

The comparison of different gas production methods is necessary to increase the reliance of data generated by each method, because *in vitro* gas production with varying equipments is increasingly being used for feed evaluation. The HGT method is the reference in the present study, and was designed for the measurement of gas production after 24 h, relating the amount of gas produced to ME content of feeds, correcting the observed values to given benchmark values. The automated pressure evaluation system (APES) was designed to generate cumulative gas production curves for the study of degradation kinetics of feeds. However, HGT and APES may generate different data sets for the same feed even using rumen fluid collected from the same batch and gas production recordings in the same days. Whereas in the HGT the gas curves are the result of measurements on fixed time points, the APES generates several valve openings for each feed, when the pressure inside the bottle has reached a fixed value. The relationship of gas production measured by the HGT method to ME content of the diet has been studied intensively so that comparison of the new APES method for gas production with the HGT method is needed before estimation of ME can be automated. In the present study, the protocol of each method was followed to generate different data points for both methods during the course of incubation. Therefore, the objective of the present study was to compare the cumulative gas production profiles generated by