The 5th INTERNATIONAL SEMINAR ON TROPICAL ANIMAL PRODUCTION
“Community Empowerment and Tropical Animal Industry”

PROCEEDINGS

Oktober 19 – 22, 2010
Yogyakarta, Indonesia

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Faculty of Animal Science, Universitas Gadjah Mada Yogyakarta
Indonesian Society for Sustainable Tropical Animal Production [ISSTAP]
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Community Empowerment and Tropical Animal Industry

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PREFACE

The Faculty of Animal Science, Universitas Gadjah Mada, is pleased to have The 5th International Seminar on Tropical Animal Production, held at our campus in Yogyakarta, on October 19-22, 2010. The previous seminar has been successes in discussing various issues at that time. Agriculture is the mainstay of the people of most tropical countries, where billion of people live. Within agriculture, a high priority is placed on animal rearing, since farm animals play important roles in the economies of the countries. The present seminar on ‘Community Empowerment and Tropical Animal Industry’ follows on in a series on tropical animal production.

The conference was aimed to gather educators, academics, researchers, industry practitioners, representatives of professional industry associations and non-government organizations in the field of animal science, to discuss issues and concerns confronting the various stakeholders in responding to the community empowerment and tropical animal industry. The conference further aimed to provide an interdisciplinary forum to facilitate the exchange of information through research and networking amongst the conference participants to foster collaborative research and academic exchanges.

The conference featured more than 200 panel, paper and poster presentations, and attendees, by animal science academics and practitioners from more than 20 countries. All the full papers and abstracts in these proceedings have been subjected to a double blind refereeing process coordinated by selected academics. The success of an international seminar with published proceedings depends on the collective team efforts of many people. We owe a significant debt of gratitude to many individuals. We wish to take this opportunity to thank these individuals who have contributed to the success of this conference. First, we would like to thank the paper and panel presenters as well as the conference session chairs for their contribution of expertise, time and efforts. We would also like to extend special thanks to the Paper Reviewers and Editors who have spared their precious time and efforts to review and edit the papers. The names of the Paper Editors are listed on the following page. The review and editing process has been a complex one given the fact that English is not the native language of many of the delegates who submitted papers for this seminar. With a number of papers it has been necessary to focus, at times, more upon intent and meaning than grammatical correctness.

We also commend the hard work done by the conference steering and organizing committees composed of the academic, administrative staff and students of the Faculty of Animal Science, Universitas Gadjah Mada.

Prof. Dr. Krishna Agung Santosa
Editor in Chief
Editor-in-Chief

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Dyah Woro Hastuti
Wirasto
Wisnu Widiarto
Good Day,
His excellency, Minister of Agriculture, Republic of Indonesia
The honourable Rector of Universitas Gadjah Mada,
Distinguished guests, participants, ladies and gentlemen,

On behalf of the organizing committee, I would like to extend our warmest welcome all supporters, presenters, and participants to the Fifth International Seminar on Tropical Animal Production 2010 in Yogyakarta, Indonesia, and indeed it is a great pleasure to see you all in our campus of Universitas Gadjah Mada, Yogyakarta.

This is a very special international event that held by Faculty of Animal Science, Universitas Gadjah Mada, Indonesia. The International Seminar on Tropical Animal Production (ISTAP) is conducted every four years. The first, second, third and fourth were conducted in 1994, 1998, 2002, and 2006, respectively. The theme of this year 2010, the 5th ISTAP is “Community Empowerment and Tropical Animal Industry”.

This forum is attended by more than 200 delegates representing 23 countries (Australia, Cameroon, Denmark, Ethiopia, India, Iran, Japan, Kuwait, Malaysia, Pakistan, Philippines, The Netherlands, Timor Leste, Nepal, Sri Lanka, Nigeria, Bhutan, Scotland, Thailand, USA, and Indonesia. There were over 170 abstracts submissions and 150 papers were accepted and will be presented at the forum. We are confident that the 5th ISTAP will be an excellent opportunity for all participants to share and learn from each other. We hope that this ISTAP will be a success and that your stay in Indonesia will be a pleasant one.

I would like to express my sincere appreciation to the keynote speaker His excellency Ir. Suswono, MMA, Minister of Agriculture, Republic of Indonesia, and the invited speakers, Prof. Dr. Dale R. ZoBell, Prof Dr. E.R. Orskov, Prof. Dr. Mogens Lund, Dr. Henning Otte Hansen, Ms. Fokje Steenstra, Mr. Vinod Ahuja, Dr. Yanin Opatpatanakit, Prof Dr. Ryo Akashi, Prof. Dr. Michio Muguruma, Prof. Dr. Tohru Suzuki and Dr. Ferry Purnama.

Furthermore, my great thanks go to the sponsors of the conference, i.e. Bank Indonesia, Bank Negara Indonesia, Bank Rakyat Indonesia Syariah, PT. Jackson Niagatama, PT. Peksi Guna Raharja, CV. Restu Bumi, Livestockreview.com, PT. Nasmoco and Murni Bakery.

I would also like to acknowledge the support in the organization of the conference of ABAD Entertainment. Similarly, I also express my sincere gratitude for the hard work and dedication displayed by our paper reviewers, editors, committee and students of Universitas Gadjah Mada.

Again, we would like to welcome you all to the Fifth ISTAP for Participants, Delegates, and Special Guests in Yogyakarta, Indonesia
Thank you.

Dr. Budi Guntoro
Chairman
Assalamu’alaikum warahmatullahi wabarakaatuh,

Honorable the Minister of Agriculture, Republic of Indonesia.
Your excellency Rector of Universitas Gadjah Mada
Distinguish guests, ladies and gentlemen

Let us thank full God almighty, that because of his amazing grace, we are all able to meet together at this International Seminar. On behalf of the Faculty of Animal Science, Universitas Gadjah Mada, it is my great privilege and pleasure to have you in Universitas Gadjah Mada.

Faculty of Animal Science, one among of 18 faculties in UGM, has been recognized as the prime educational institution in Indonesia, providing teaching, research and extension programs in science and animal industry including animal nutrition, animal production, technology of animal products and livestock social economics.

This is the fifth International Seminar on Tropical Animal Production (5th ISTAP), and the like the first until the fourth ISTAP, is the agenda of own faculty to be conducted once after every four years. The aim of this respective will contemplate in-depth community empowerment and animal industry problem in the tropical developing countries. The big problem which are constituting a challenge in tropical developing countries, particularly in Indonesia, among other things are the economic transformation and the trend of economic globality.

Finally, on behalf of the Faculty, I extend my sincere gratitude to honors Minister of Agriculture the Republic of Indonesia, for your kind and generosity to include this event on your busy time schedule and be with us to give keynote speech and talk policy matters. We have proud and full of honourable to have invited speakers from all around the world as well as all participants derived from many universities, research institutes, related governmental offices and industries in Indonesia. Four-day conference hopefully would yield valuable solution and discussion in livestock production with holistic management of local resources could be successfully. By this opportunity, I would like to thank all parties and members of both Steering and Organizing Committees, who have devoted their time to make this seminar success. Allow me for this event, to request Prof. Dr. Sudjarwadi to officially open this seminar. Thank you.

Wassalamu’alaikum warahmatullaahi wabarakaatuh.

Prof. Dr. Tri Yuwanta
Dean
Assalaamu’alaikum warahmatullaahi wabaraakaatu

The honorable Ministry of Agriculture Republic of Indonesia
Distinguished Guests, Participants of the seminar, and Ladies and Gentlemen.

It is my pleasure to welcome all of you to the campus of Universitas Gadjah Mada to attend the 5th international Seminar on Tropical Animal Production. This seminar is more or less a respond to the recommendation forwarded at the 4th International Seminar on Tropical Animal Production held in 2006.

Ladies and Gentlemen

Universitas Gadjah Mada on behalf of Faculty of Animal Science is very delightful to host this fourth yearly seminar. First of all, I would like to thank and express my appreciation to the Dean of Faculty of Animal Science and all members of the committee of the seminar who have been working very hard to make the seminar successful.

The large numbers of representative we have here from all around the world indicate that the interest generated in animal production is real and trying to affect the resources of rich and poor nations.

Secondly, on this significant occasion I would like to express as well sincere gratitude to the Minister of Agriculture, Ir. Suswono, MMA for your special speech.

The theme of fifth International Seminar on Tropical Animal Production is “Community Empowerment and Tropical Animal Industry”. Since animal production in the tropics has been developed rapidly in order to provide high quality food, however it still very much depends on science, technology, and resources from developed countries. Overseas depending resources make agriculture development difficult to be sustainable. It is urgent to concern and take responsibility for sustainable development of agriculture which integrates three main goals: environmental health, economic profitability and social economic equity.

This seminar will be hopefully being continued as a forum of researchers, specialists in animal science and technology for tropical countries. In our constant effort to improve the food production and technology for tropical countries, we very much depend on cooperatives efforts of scientists who have already improved livestock production in the region.

Finally, I do hope you enjoy very much this seminar and your stay in Yogyakarta. Thank you very much.

Wasslaamu’alaikum warahmatullaahi wabaraakaatu

Prof. Dr. Sudjarwadi
Rector
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INSTRUCTIONS TO AUTHORS
The measurement of rate of passage using different pairs of alkane as markers for sheep fed hay or fresh grass

Kustantinah,* R.W. Mayes,† E.R. Orskov‡

*Faculty of Animal Science University of Gadjah Mada, Yogyakarta, Indonesia; and †The Macaulay Institute, Craigiebuckler, Aberdeen AB15 8QH, UK

ABSTRACT: This study used alkanes marker absorbed in the paper bung. Four pairs of alkanes: C30:C32, C28:C34, C26:C36 and C24:C38 were introduced to sheep by mouth, with a different time of dosing. The first group of sheep (n = 6) that were fed hay and second group of sheep (n = 4) were fed fresh ryegrass at similar dry matter intake (DMI), from the alkane marker excretion were calculated residence time of digesta in the digestive tract (mean retention time / MRT). MRT calculations were performed for each individual alkane on each individual sheep with two different feed. From the calculation, it was found that the MRT obtained in the group of sheep fed hay was 35.8 hours (C24), 43.0 hours (C26), 41.6 hours (C28), 40.1 hours (C30), 40.8 hours (C32), 42.0 hours (C34), 48.0 hours (C36), and 40.3 hours (C38). In the group sheep fed fresh ryegrass, the estimated MRT was 32.2 hours (C24), 41.7 hours (C26), 36.3 hours (C28), 40.3 hours (C30), 40.9 hours (C32), 36.6 hours (C34), 45.2 hours (C36), and 34.5 hours (C38). It can be seen that in general the value of MRT for sheep fed hay gave a higher value when compared with the MRT in the group fed fresh ryegrass, although statistically the MRT of the two groups did not differ significantly, except for MRT estimated using marker C38. MRT which estimated using the C38 gave a significant difference (P <0.05), i.e. 40.3 hours in sheep fed hay and 34.5 hours in sheep fed fresh ryegrass. The results of observations made, indicated that, for all types of markers and in all groups of sheep, in general there was no significant differences between MRT, except for C24 vs C36 (P<0.05) for groups of sheep fed hay and for C24 vs C36, and C28 vs C36 (P<0.05) for the group of sheep fed fresh ryegrass. The use of these alkanes markers were absorbed in paper bung provides a good estimation of the MRT.

Key words: mean retention time, alkane, sheep, hay and fresh ryegrass

INTRODUCTION

Some breeds of ruminant livestock are able to utilise vegetation more efficiently than other breeds, probably due, at least in part, to morphological and physiological differences in the digestive tract. Animals with an inherent ability to digest food more efficiently are likely to have higher digestive tract volumes and slower passage rates than other animals. Such knowledge of gut passage rates in different genotypes could be useful in trying to help explain differences in animal behaviour and pasture utilisation in cattle, sheep or goats grazing in upland environments. Breeding animals to have larger gut volumes and slower passage rates could enable animals to digest roughage diets more effectively. If there were an easy method of determining gut passage rate it has the potential to be used as a selective breeding tool. Mould et al (1983) showed a large differences between Bos Indicus (Bangladesh cattle) and Bob taurus (beef cattle in the UK), in ability to consume low quality forage. Similarly, rumen volume is strongly influenced by the period (time) of gestation and lactation (Kay, 1990), whereas Hoffman (1989) showed that variation of the size of stomach was caused by the quality of the feed. Some times ruminants are selected to have a low rumen volume (Hoffman, 1989), as it gives higher carcass weight relative to body weight.

Studies on the feed passage rate continues to evolve. Observations on the flow rate has been made for about 50 years by using various kinds of markers, and also various equations to calculate flow rate. An alternative method based on the analysis of plant alkanes in herbage and feces has been used to estimate DMI in ruminants (Mayes et al 1986, 1995, Dove and Mayes, 1996). The n-alkanes are saturated straight-chain hydrocarbons located in the cuticular wax of plants (Dove and Mayes, 1991). Natural alkanes were developed as marker to estimate intake, diet composition and digestibility by herbivores (Dove and Mayes, 1991). Dove and Mayes (1991) proposed using alkanes as marker for
measuring rate of passage. Studies in ruminants indicated that fecal recovery of alkanes increased with increasing chain length (Mayes and Lambs, 1984, Mayes et al., 1986).

The extent to which dietary components are fermented in the rumen is a function of potential rate and extent of fermentation and residence in the rumen. The residence in the rumen, usually expressed as the mean retention time (MRT), and can be determined from the decrease in the faecal concentration of a non absorbable marker in rumen. The faecal marker excretion technique (Grovum and William 1973) overcame the problem of representative sampling and has the advantage that fistulated animals are not necessarily required. Giradez et al (2004) have examined the rate of feed passage using carrier matrix different. Marker C24: cellulose powder, C26: paper bungs, C28: Gibson paper filters, C30: Cellulose powder, and C32: Shredded paper. While’s Bulang et al (2008). Were studied rate of passage use different marker. Different carrier matrices (lucerne fiber vs coarse maize meal) were labelled with synthetic alkanes C28 and C36.

The objective of this research was to investigate utilisation of pairs of alkanes as markers for measuring rate of passage by single dose for two different groups of animals, one group of sheep were fed hay consisting of mixture of ryegrass and clover and the second group of sheep were fed fresh ryegrass.

**MATERIALS AND METHODS**

**Preparation of Marker Doses**

Each alkane dose consisted of a pair of even-chain alkanes absorbed into tissue paper bungs (‘Cellucotton filters’- Carl Roth gmbh, Germany). The alkane pairs for the doses were as follows: Dose 1- C30/C32; Dose 2 – C28/C34; Dose 3 – C26/C36; Dose 4 – C24/C38. The doses were prepared in a fume cupboard, by dispensing a hot solution containing both alkanes of the pair (about 10% w/v in n-heptane, 60°C) on to each paper bung, after the bungs had been preheated to 130°C. The bungs were left in the fume cupboard over night to allow the solvent to evaporate. They were then placed in a oven at 100°C for 5 min, so that the alkane melted and was absorbed into the bungs.

**Animal and Diets**

Twelve adult Scottish Blackface sheep (average live weight 26.75 kg) were maintained on either hay consisting of mixture of ryegrass and clover (six animals) or fresh perennial ryegrass (six animals) in individual pens for two weeks as an acclimatisation period. The hay treatment was medium-quality grass hay collected from a single ‘big bale’ and chopped and mixed prior to feeding. After the acclimatisation period the sheep were transferred to metabolism cages and maintained on the same diet and feeding level throughout. The animals had constant access to water and were fed twice daily.

**Marker Applications and Sampling Procedure**

After two days in the cages animals on each dietary treatment were orally dosed as follows:

1. Artificial alkane Dose 1 (C30/C32)
2. Artificial alkane Dose 2 (C28/C34)
3. Artificial alkane Dose 3 (C26/C36)
4. Artificial alkane Dose 4 (C24/C38)

Following the first dose, total faecal collection bags were changed as the experimental period progressed according to the timetable.

**Analytical Procedure for n-Alkanes in Sheep Faeces (Modification of Dove and Mayes, 2006)**

Samples of faeces collections were freeze-dried and milled before analysis. Individual samples for each sheep at each sampling time were analysed for n-alkanes using 0.1g samples run in duplicate. After weighing the samples into screw-capped tubes (4ml capacity) approximately 0.11g of internal
standard solution (n-docosane (C$_{22}$) and n-heptacosanol (C$_{27}$) in n-decane) was added by weight. Ethanolic potassium hydroxide solution (1.5ml, 1M) was added. The tubes were capped and heated for 16 h at 90°C in a dry-block heater.

After partial cooling, (to 50 – 60°C), 1.5 ml n-heptane was added; the tube was capped and shaken gently. Water (0.4ml) was added and the tube, after re-capping, was shaken vigorously. The tubes were rest to allow the contents have separated into two liquid layers; if separation was not complete, tubes were centrifuged at low speed (1000rpm) for 5 min. The top (non-aqueous) layer was transferred to a second 4 ml tube using polyethylene pasteur pipettes. A second aliquot (1.5 ml) of heptane was added to the tube and the extraction was repeated, adding the top layer to the first non-aqueous extract in another 4ml tube. The tubes containing the non-aqueous extracts were placed on a dry-block heater fitted with a sample concentrator blowing air into the tube. The dried extract was redissolved in 0.3 ml heptane, with warming, and gently applied to a small column containing silica gel with a bed volume of 1 ml. Heptane (0.1 ml) was added to the column to wash the extract into the silica-gel bed. The hydrocarbons (including the n-alkanes) were eluted from the column into a third 4 ml tube by the addition of a further 2.4 ml n-heptane. The heptane in the eluate was removed by evaporation to dryness on a dry-block heater. The hydrocarbon fractions obtained from the total collection faecal samples were dissolved in 0.5ml n-heptane, with warming; a small aliquot (50µl) was transferred to a GC autosampler vial and the heptane removed by evaporation. The dried hydrocarbon aliquot was redissolved in 30µl n-dodecane and the autosampler vial was capped prior to analysis by GC.

**Calculation of Faecal Alkane Concentrations**

A data file produced by the Chromquest software, which contained peak areas was imported into Excel spreadsheet software; all subsequent data processing was carried out using Excel software.

For each GC run, the ‘area %’ of each alkane peak was calculated:

\[
\text{Area\% alkane}_i = \frac{\text{Peak area of alkane}_i \times 100}{\text{Peak area of IS alkane (C$_{37}$)}}
\]

Next, the standard response factors (SRF) for each alkane (alkane$_i$) were calculated:

\[
\text{SRF}_i = \frac{\text{Area\% alkane, in mixed standard}}{\text{Wt\% alkane, in mixed standard}}
\]

where:

\[
\text{Wt\% alkane}_i = \frac{100 \times \text{Wt of alkane, in mixed standard solution}}{\text{Wt of IS alkane (C$_{37}$) in mixed standard solution}}
\]

The second internal standard (C$_{22}$ alkane) was used to calculate a fractionation factor (FF), which enables a correction to be made for any chain length-dependent variation in degree of extraction of alkanes. This is based on the concept that without fractionation (discrimination) at the extraction stage, the ratio of the internal standard peak areas (i.e. C$_{22}$:C$_{37}$), after correction for GC responses, will be the same as the ratio of the amounts of each internal standard added to the sample. For C$_{22}$ internal standard, the fractionation factor (FF$_{22}$) was calculated as follows, for each GC sample run:

\[
\text{FF}_{22} = \frac{\text{Area\% C$_{22}$ in sample} / \text{SRF}_{22}}{100 \times C_{22} : C_{37} \text{ concentration ratio in IS solution}}
\]

Assuming that there was a linear change in fractionation factor with chain length, the fractionation factors for the other alkanes were calculated as shown:

\[
\text{FF}_i = (i - 22) \times \frac{1 - \text{FF}_{22}}{15} + \text{FF}_{22}
\]

Having added sample and internal standard weight data, and dry-matter (DM) concentrations to the Excel spreadsheet, the concentrations of n-alkanes in faecal samples could then be calculated:
6. Gut passage rate calculations

The following set of procedures were used in the processing of the data: Subtract ‘background’ faecal concentrations of markers from the marker concentrations in faeces samples collected after administration of the first marker dose. Calculate the mean retention time (MRT) for each marker in each sheep, using equation of Faichney (1975).

Statistical Analysis

Data for the MRT were analyzed using analysis of mean differences (T test), the correlation between the MRT and peak time analyzed using linear regression, while comparison of the mean of the individual alkane in the same feed, using one way ANOVA. All calculations of data using statistical program statistical product and service solution (SPSS) for windows version 17.

RESULTS AND DISCUSSION

Dry Matter Intake

The average live weight of the sheep used in this study was 26.7 kg, the average of live weight was almost the same for both of group I and II used in the measurement of mean retention time of sheep fed hay and sheep fed fresh ryegrass. Dry matter intake was 379 ± 22 grams per head per day in groups of sheep fed hay and 376 ± 6 grams per head per day in groups of sheep fed fresh ryegrass (Table 1).

Table 1. Dry matter intake

<table>
<thead>
<tr>
<th>Sheep no</th>
<th>Feeds offered</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hay</td>
<td>Fresh Ryegrass</td>
</tr>
<tr>
<td>1</td>
<td>378 ± 23</td>
<td>387 ± 21</td>
</tr>
<tr>
<td>2</td>
<td>399 ± 0.2</td>
<td>349 ± 35</td>
</tr>
<tr>
<td>3</td>
<td>381 ± 30</td>
<td>383 ± 27</td>
</tr>
<tr>
<td>4</td>
<td>391 ± 14</td>
<td>385 ± 23</td>
</tr>
<tr>
<td>5</td>
<td>336 ± 48</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>387 ± 28</td>
<td></td>
</tr>
<tr>
<td>Mean live weight (Kg)</td>
<td>26.75</td>
<td>26.75</td>
</tr>
<tr>
<td>Average DMI±StDev (gr/head)</td>
<td>379.08 ± 22.16</td>
<td>376.69 ± 6.12</td>
</tr>
</tbody>
</table>

*a,b* Different superscripts in the same row indicate a significant difference (P<0.05)

Marker Excretion Curve

Marker excretion was observed during the 9 days, and the calculations take into account the excretion of fecal samples collected based on the time of collection. Marker excretion curve was observed for each pair of markers which is C30/C32, C28/C34, C26/C36, and C24/C38 for the group of sheep fed hay (Group I) and for the group of sheep fed fresh ryegrass (Group II). Overall, it was observed that, each pair of marker alkanes gave a similar curve patterns with one another, it was observed for both groups of sheep fed differently. In making the calculation of the curve, the concentrations of alkanes (g/kg DM) was reduced by the existing content of alkanes in the feces before the introduction of markers. Curves obtained, on all pairs were similar to the normal curve (Figure 1).
By calculating each MRT alkane markers that are not significantly different, then we have conducted adjustment curve for marker pairs C26/C36 and C24/C38 (Figure 1). Overall, the concentration curve of marker excretion (mg/kg DM) to ryegrass was always higher, when compared with the hay diet. Concentration highest in the ryegrass reached 700 mg/kg DM for the C30 and C32, 500-550 mg/kg DM in the C26, C28, C34, C36 and reached 600 mg/kg of DM at C24 and C38. Different observations obtained for hay, which is overall marker excretion was approximately 300 mg/kg DM, this applies to all alkane markers (Figure 1).

If all marker pairs were observed together with observed excretion markers individually, it was found that the marker pairs C24/C38, is the earliest marker excreted both for sheep fed hay and for sheep fed fresh ryegrass, and pairs of C26/C36 out the most latest marker, for both of sheep fed differently.

![Figure 1. Faecal total collection sample concentration (mg/Kg DM) plotted against time (h) after marker dosed for sheep fed hay (n=6) and for sheep fed ryegrass (n=4)](image)

**Table 2.** Mean Retention Time (MRT) calculated from difference marker (Mean ± S.E.M)

<table>
<thead>
<tr>
<th>Feeds</th>
<th>Total Mean Retention Time (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hay (n=6)</td>
<td>C24</td>
</tr>
<tr>
<td></td>
<td>35.8±</td>
</tr>
<tr>
<td>(SEM)</td>
<td>(0.3)</td>
</tr>
<tr>
<td>Fresh ryegrass (n=4)</td>
<td>32.2±</td>
</tr>
<tr>
<td>(SEM)</td>
<td>(0.2)</td>
</tr>
</tbody>
</table>

\[a, b\] Different superscripts in the same column indicate a significant difference (P<0.05)

The calculation of the MRT showed that in the same feed, the MRT calculated from each individual alkanes, the lowest MRT was 35.8 ± 0.4 hours (estimated based on C24) and the highest MRT was 48.0 ± 0.7 hours, (estimated from the C36) (Table 2). These value were obtained in sheep.
fed hay (n = 6). While in the group of sheep fed fresh ryegrass, the MRT estimates ranged from 32.2 ± 0.2 hours when estimated using marker C\textsubscript{24} and MRT of 45.2 ± 1.1 hours when estimated using C\textsubscript{36}. It can be stated that, for all markers in group of sheep fed hay, in general there was no significant differences between MRT, except for C\textsubscript{24} vs C\textsubscript{36} (P<0.05), and in group of sheep fed fresh ryegrass there was no significant differences between MRT, except for C\textsubscript{24} vs C\textsubscript{36}, and C\textsubscript{38} vs C\textsubscript{36} (P<0.05).

### Dry Matter Intake

Feed offered to sheep in this study was hay consisting of mixture of ryegrass and clover or fresh ryegrass or commonly called *Lolium perenne*. Naturally, ryegrass already contains the n-alkane (Cortes *et al.*, 2005, Dove *et al.*, 1996, Stevens *et al.*, 2002). For example (Ferreira *et al.*, 2009) showed that even-alkane concentration of *L. perenne* was 2.2 mg/Kg DM for C\textsubscript{26}, 9.4 mg/Kg DM for C\textsubscript{28}, 11.1 mg/Kg DM for C\textsubscript{30}, and 6.1 for C\textsubscript{32}. The grass naturally contain an alkanes, which was substracted from the faeces to separate alkane marker from the basal feeds.

The quantity of feed given was restricted, rather than ad libitum. This was to avoid bias, which may be obtained if the feed is ad libitum, because as described above, that ryegrass naturally, already contain alkanes. So, with the restricted diet, the initial alkane content, was not expected to significantly different for each individual animal. Although the feed offered was limited, the DMI of both groups of sheep were 379 g/head/day (hay) and 376 g/head/day (fresh ryegrass). No significant differences between the two DMI. DMI was approximately 1.4% of body weight.

### Excretion Marker Curve

Visible curve for each pair of markers gave the same pattern, as well as providing value of peak time and MRT did not differ statistically, meaning that in fact when used alkane as a marker for the measurement of the MRT, then only needed one of these alkanes in pairs (Figure 3). In this study fecal alkane recovery has not measured, but from previous research, it was found that the faecal recovery of n-alkane increased with the C-chain length (Duncan *et al.*, 1999, Mayes *et al.*, 1986 and Giraldez *et al.*, 2006). For example, Giraldez *et al.* (2004) found that the faecal recovery of alkanes was 77% for C\textsubscript{24}, 81% for C\textsubscript{28}, 92% for C\textsubscript{30} and 95% for C\textsubscript{32}, while Ferreire *et al.* (2009) showed that the faecal recovery of mixture of herbage was 40% for C\textsubscript{28}, 75% for C\textsubscript{30}, 92% for C\textsubscript{32}.

Alkane excretion patterns for shep fed hay and fresh ryegrass were different, for peak excretion of sheep fed hay was reached at concentrations around 300 mg/kg DM, while in the sheep fed ryegrass, peak excretion was reached at concentrations above 500 mg/kg of DM (Figure 3). This excretion pattern similar to that obtained by Duncan *et al.* (1999) who compared Spinach and cabbage or a mixture of grass-dominated pasture-phleum pratense Timothy.

### Mean Retention Time (mean±s.e.m)

Alkane pair data, provided no significant differences of MRT when compared in pairs C\textsubscript{30}/C\textsubscript{32} different feed, either observed for the pair C\textsubscript{28}/C\textsubscript{34}, C\textsubscript{26}/C\textsubscript{36} and C\textsubscript{24}/C\textsubscript{38}.

The digesta flow or the residence time of food particles can be used to predict fibre digestibility (Veira *et al.*, 2008a, Veira *et al.*, 2008b, Stensig *et al.*, 1999, Huhtanen *et al.*, 1995) so that the flow rate or residence time will be reflected in dry matter intake (DMI). Giraldez *et al.*, (2006) stated that there be an increase in the level of intake is generally related to flow rate.

MRT was calculated from pair of alkane C\textsubscript{30}/C\textsubscript{32} were 40.4 and 41.5 hours, consecutively for hay and ryegrass and pairs of alkane C\textsubscript{28}/C\textsubscript{34} were 42.1 hour for hay and 36.4 hour for fresh ryegrass, and pairs of alkane C\textsubscript{26}/C\textsubscript{36} were 45.6 hours for hay and 43.4 hours for fresh ryegrass, for the pairs of alkane C\textsubscript{24}/C\textsubscript{38} were 38.3 hours for hay and 33.3 for fresh ryegrass. No significant differences were found between the feed.

MRT values in this study, was 10 points lower when compared to the MRT as measured using marker mordanted Cr-fiber (Giraldez *et al.*, 2006), with similar diet, but the value in this study was 10 points higher if MRT estimated using alkanes sprayed on leaves or on stems, (Giraldez *et al.*, 2006). Similar value obtained of MRT when estimated using the absorbed C\textsubscript{26} paper bung (Giraldez *et al.*, 2006),
While Bulang et al (2008) found high values for the estimated of MRT when estimated using marker Cr mordanted in Lucerne. It appears there was a consistency of usage of Cr is to give value always higher when compared to estimates using alkanes. MRT estimated from the mean of each marker pairs, showed that the type of feed was not making any differences on the MRT, the same observation was found to peak time, when observed in one feed, apparently in sheep fed hay, pair marker C_{30}:C_{32}, C_{28}:C_{34}, C_{26}:C_{36} and C_{24}:C_{38}, did not make a difference significantly. Whereas for sheep fed ryegrass, MRT estimated from marker pairs C_{30}:C_{32}, C_{28}:C_{34} and C_{26}:C_{36}, provided no difference significantly, but the MRT for sheep fed on ryegrass, which are estimated pair alkanes C_{26}:C_{36} differ significantly from the MRT which are estimated using the alkane pair C_{24}:C_{38} (P <0.05).

Alkanes absorbed in the paper bung, apparently were released faster and better mixed with the digesta in sheep fed ryegrass than in sheep fed hay.

CONCLUSIONS

In general, the marker excretion curve, for each individual alkane showed the same pattern for each type of feed, so that the group of sheep fed hay gave a similar pattern of excretion curve to the group of sheep fed ryegrass, but with different peaks.

Marker excretion curve for pairs of markers C_{30}:C_{32}, C_{28}:C_{34}, C_{26}:C_{36} and C_{24}:C_{38}, gave a similar pattern for each type of feed, although the sheep fed ryegrass gave higher peak of the curve when compared to sheep fed hay.

There was no significantly difference between MRT in sheep fed hay and sheep fed ryegrass when estimated from individual each marker.

LITERATURE CITED


Certificate

Kustantinah

It's hereby certified that

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Prof. Dr. Tri Yuwanta

Dean

Faculty of Animal Science

Universitas Gadjah Mada

[Signature]