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USE OF TRITIATED WATER FOR ESTIMATION OF DRY MATTER INTAKE IN GRAZING CATTLE

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RINGKASAN

Satu percubaan untuk menguji kaedah penentuan pengambilan bahan kering menggunakan air beradioisotop tritium telah dilakukan ke atas lembu-lembu dara baka Jersey dan LID-Jersey berumur antara 15 hingga 18 bulan. Lembu-lembu tersebut telah diberi makan dengan rumput *Panicum maximum* secukupnya dan 3 kg 'pellet' sehari pada setiap ekor. Air juga diberi secukupnya. Lembu-lembu itu kemudian disuntik dengan air beradioisotop tritium bagi menentukan pulangan air tubuh. Kandungan air pada makanan yang diambil ditentukan daripada perbezaan pulangan air terhadap air yang diminum dan air daripada 'pellet'. Nilai ini dan nilai peratus berat kering rumput digunakan untuk menganggarkan berat bahan kering yang diambil oleh haiwan tersebut. Nilai sebenar ditentukan daripada kandungan air dalam makanan dan jumlah makanan yang diambil. Jumlah pengambilan makanan yang diukur (5.18 kg/ekor/hari atau 2.21% berat badan/hari) didapati tidak berbeza ($P>0.1$) dengan nilai yang dianggarkan (5.26 kg/ekor/hari atau 2.24% berat badan/hari) dan purata perbandingan kedua-dua nilai adalah 1.01.

Pengambilan bahan kering oleh tujuh ekor lembu kacukan Sahiwal-Friesian yang meragut antara jam 1 500–1 100 setiap hari di padang ragut rumput *Setaria sphacelata* var. Splendida dan diberi 2 kg 'pellet' menggunakan kaedah yang sama ialah 14.42 kg/ekor/hari atau 4.06% berat badan sehari.

Oleh itu, dengan menggunakan air beradioisotop tritium bagi menentukan pulangan air tubuh, mengukur air yang minimum dan kandungan air dalam rumput dan 'pellet', maka pengambilan bahan kering ternakan lembu yang meragut dapat ditentukan.

INTRODUCTION

The most difficult part in assessing the feed intake in individual animal is when the animal is grazing. This becomes a challenge in evaluating the performance of various breeds and crossbreds in pasture where its feed efficiency in terms of gain per unit feed intake cannot really be determined because of the difficulty of accurately measuring the quantity of food an individual animal ingests. Comparisons of breeds in large scale trials have included management, fertility, survival rate, disease resistance, growth rates and carcass composition, but not feed intake. Where information on group feeding is sought, pasture dry matter intake can be measured by cutting samples before and after grazing, but the method is not very accurate. While for individual intake, the method most commonly used involved measuring the dilution of chromium oxide (FAICHNEY, 1975). This too, has large source of errors (WRIGHT, 1982).

Attempts have been made to use tritiated water as a tracer for measuring the quantity of feed an animal consumes. It has been demonstrated that there is a correlation between water turnover and faecal dry matter excretion in grazing sheep (SIEBERT, 1971; MACFARLANE, HOWARD and GOOD; 1974). As water turnover is equal to water intake from drinking water plus water from food ingested, therefore water from food can be estimated by measuring water turnover and water intake from drinking water. Thus, the dry matter intake can be estimated if the water content of the food is known. Another source of body water which is not considered in the calculation is water from metabolic body water. The value of metabolic body water, however is small and assumed to be nil (ROBERTSHAW, *pers. comm.*, 1982).

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of radioisotope injection, blood sampling, analysis of tritium and calculation were carried out similarly as in the first experiment.

The water intake and concentrate given were measured; and the grass samples from the pasture were taken three times daily for determination of the dry matter content of the pasture.

RESULTS AND DISCUSSION

The results on the estimated dry matter intake derived from water turnover and the measured dry matter intake of the animals are shown in *Table 1*. It was found that the mean of the estimated dry matter intake (5.26 kg/day/animal) was not significantly different ($P<0.1$) from the actual intake (5.18 kg/day/animal) and the ratio between the mean of estimated *vs.* measured dry matter intake was 1.01. Both estimated and measured dry matter intake were significantly correlated ($P<0.01$, $r = 0.95$).

The results indicated that the tritiated water dilution technique can be used to estimate the dry matter intake in cattle with a great accuracy as reported in small ruminant (BENJAMIN, CHEN, DEGEN, ABDUL AZIZ and AL HADAD, 1977). In comparison with other techniques, the tritiated water dilution method is simpler and more reliable. Faecal output collection technique can reduce animal performance (CORBETT, 1960) due to lower intake (MILNE, 1974) and high energy expenditure (REID, 1966) caused by the stress of the equipment. Furthermore, the total faecal collection technique has high labour requirement (GREENHALGH, 1974) and difficult to collect faecal free urine with female animal. Although estimation of faecal output using chromium oxide as the feed marker overcomes most of the problems involved in the total collection technique, it still has some errors. This was mainly due to the diurnal variation in faecal marker concentration thus deviating from the assumption that 100% of the marker is recovered in the faeces (MEIJS, 1981). The technique using fistulated animal has limitation in that it is not applicable for a study using a large number of animals. Therefore,

Table 1. Comparison of the estimated dry matter intake and measured intake in heifers

Animal breed	Body weight (kg)	Water turn-over rate (litres/day)	Total water intake (litres/day)	Estimated water from feed* (litres/day)	Total dry matter intake (kg/day)*		Ratio estimated measured
					Estimated	Measured	
LID–J	233	20.14	9.53	10.61	5.75 (2.47)	5.88 (2.52)	0.98
LID–J	231	22.32	11.26	11.06	5.88 (2.54)	5.89 (2.55)	1.00
LID–J	268	27.17	14.13	13.04	6.46 (2.41)	5.72 (2.14)	1.13
J	214	20.95	14.96	5.99	4.38 (2.05)	4.45 (2.09)	0.98
J	244	21.39	15.63	5.76	4.31 (1.77)	4.42 (1.81)	0.98
J	234	24.87	15.20	9.67	5.47 (2.34)	5.40 (2.31)	1.01
J	219	20.45	13.86	6.59	4.56 (2.08)	4.50 (2.06)	1.01
Mean	234	22.47	13.51	8.96	5.26[a] (2.24)	5.18[a] (2.21)	1.01
±	17		2.27	2.86	0.84 (0.28)	0.70 (0.27)	0.05

± Standard deviation
LID–J Local Indian Dairy - Jersey crossbred
J Jersey
a Comparison of means in row at $P<0.01$
* Dry matter of grass = 22.8%
Dry matter of concentrate = 90.0%, given at 3 kg/animal/day
( ) Value in percentage of body weight/day.

The possibility of using water turnover rate technique to estimate the dry matter intake therefore is obvious. Therefore, an experiment was conducted with stall-fed cattle to evaluate this technique by comparing the estimated *vs* measured dry matter intake. The technique was then tested on a group of grazing animals.

MATERIALS AND METHODS

An experiment to evaluate the technique of using tritiated water to estimate dry matter intake was carried out on a group of heifers. The group consisted of seven heifers, four Jersey and three Local Indian Dairy x Jersey crosses (LID-J) with the age ranging from 15 to 18 months. The purpose of using two breeds of animals was to get a wider range of body weight and therefore, widen the range of feed intake values as the feed intake is correlated with body weight.

Individual animals were stall-fed with cut Guinea grass *(Panicum maximum) ad libitum* and supplemented with 3 kg of commercial cattle pellet (15% crude protein) per animal daily. Water was also available *ad libitum*. Feed and water intake as well as the water content of the grass and cattle pellet given were recorded daily. A day prior to isotope injection, these animals were starved and continued without food and water the night following injection. The purpose of starving the animals was to reduce the body water turnover and allowed maximum mixing of injected tritiated water with body water before the isotope disappeared from the circulation.

The animals were injected intramusculary with tritiated water at the dose rate of 3.7 mßq/kg body weight in the afternoon. Ten millilitres of blood samples were taken through the jugular vein prior to injection and at two days intervals for 15 consecutive days following injection. Plasma samples were immediately separated and kept frozen at −10° Centigrade.

The radioactivity of tritium in the plasma was determined by the method of SPRINGELL and WRIGHT (1976). Dioxane (500 μ litre) was added to duplicate thawed plasma samples (500 μ litre). After vortexed, the protein precipitate was isolated by centrifugation at 3 000 rpm for 30 minutes. Supernatant (200 μ litre) was transferred into counting vial containing 10 ml of scintillation cocktail (PCS, Amersham). The radioactivity of tritium was then measured using liquid scintillation spectrometer (Beckman, Model 250).

The average specific radioactivities of tritium for each sample of each animal were plotted against the sampling time. The water turnover was calculated as described by HOLLEMAN, WHITE and LUICK (1982).

Water intake from grass was estimated by subtracting the intake of drinking water and water from the concentrate from the water turnover rate volume. By knowing the dry matter content and the value of the water intake the dry matter intake of the grass then was calculated using the following formulae:

$$\text{Dry matter intake} = \frac{\text{Water intake from grass x dry matter (\%)}}{\text{100-dry matter (\%)}}$$

Total dry matter intake = dry matter intake (grass) + dry matter intake (concentrate).

The technique was then applied on a group of seven dry Sahiwal/Friesian cows to estimate their dry matter intake. The cows which were about three years old and weighed between 280 and 430 kg, were left for grazing on a five-hectare pasture of *Setaria sphacelata* var. Splendida. The animals were kept in the shade between 1 100 h to 1 500 h during which the water *ad libitum* and concentrate (2 kg/animal/day) were given individually.

Radioisotope injection and blood sampling were carried out in the shade during the time when the animals were given concentrate and water. The procedure

Table 2. Dry matter intake of grazing by Sahiwal-Friesian cows

Body weight (kg)	Total body water (% b.w.)	Water turnover (litres/day)	Water intake (litres/day)	Water from feed* (litres/day)	Total dry matter intake	
					kg/day	% b.w./day
378	74.7	56.22	0.00	56.02	14.51	3.84
280	78.0	44.17	0.37	43.60	11.70	4.18
340	68.7	41.93	0.00	41.73	11.27	3.32
392	77.5	62.02	1.70	60.12	15.45	3.94
279	67.1	51.24	0.36	50.68	13.30	4.77
428	82.9	63.93	0.00	63.73	16.27	3.81
403	76.4	74.21	0.70	73.31	18.44	4.58
357	75.0	56.25	0.45	55.60	14.42	4.06
59	5.5	11.48	0.61	11.96	2.56	0.49

*Dry matter of the grass = 18.5%
Dry matter of the pellet = 90.0%, given at 2 kg/animal/day.

the indirect measurement of dry matter intake using tritiated water dilution technique seems to be the most suitable at the moment. The estimation is only based on the water intake from the feed consumed and water taken by the animal and thus, it gives the advantage in that the animals are allowed to have excess water whereby this then allowed the animals to have normal feeding. Since it requires the blood samples and simple analysis, water intake and dry matter measurement, therefore, the technique is easy to conduct in the field.

The technique however, has its limitation. The result depends on the accuracy of the total body water determination. For wet pasture, such as due to rain, it requires frequent sampling to reduce the error of estimating the dry matter content of the pasture.

Since the results of the estimated dry matter intake were agreeable with the measured values, therefore, the estimated values can be used without any adjustment for estimation of the dry matter intake.

The estimated values of the dry matter intake of seven dry Sahiwal-Friesian cows grazed on *Setaria sphacelata* var. Splendida are shown in *Table 2*. The mean dry matter intake of the animal supplemented with 2 kg of concentrate was 14.42 kg/day/animal or about 4.06% body weight. The result seems to be higher than the result found for the stall fed animals in the first experiment. It is possible that the grazing animals had better opportunity to choose fresh, young grass which was more palatable and this might be the reason for the dry matter intake of grazing animal to be higher than stallfed animal. Dry matter intake of grazing cows in this experiment is also higher than that obtained using the sward cutting technique (MEIJS, 1981), fistulated animal (JONES, DRAKE-BROCKMAN and HOLMES, 1965) and faecal index technique (HOLMES, CAMPLING and JOSHI, 1972). Unfortunately, the digestibility of the grass sample which might explain the higher intake found in this study, was not determined in this experiment.

In conclusion, the dry matter intake of grazing animals can be determined accurately from water turnover rate, water intake and dry matter content of the homogeneous pasture. Using this technique, the dry matter intake of the animals grazing between 1 500 h and 1 100 h daily was higher than the stall-fed animal and thus indicated that the grazing animal could perform better than stall-fed animal provided that the stocking rate of the pasture is suitable and the animal grazes during the cooler part of the day.

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ABSTRACT

An experiment was conducted on heifers to evaluate the technique using tritiated water for the measurement of dry matter intake. Four Jersey and three LID-J, 15 to 18 months old were used. The animals were stall-fed with *Panicum maximum ad libitum* and supplemented with concentrate (3 kg/animal/day). Water was given *ad libitum*. Tritiated water was injected to the animals to measure the water turnover rate. Water intake from the feed was estimated from the difference between water turnover rate and water from concentrate plus water drank. The final value and the value of dry matter content of the grass were then used to calculate the dry matter intake of the animals. The measured value of dry matter intake was calculated from the dry matter content of the grass consumed and the total dry matter intake from the concentrate. The estimated dry matter intake (5.26 kg/animal/day or 2.24% body weight/day) was not significantly different ($P>0.1$) from the measured intake (5.18 kg/animal/day or 2.21% body weight/day). The ratio between the former over the latter was 1.01.

The dry matter intake of seven dry Sahiwal-Friesian cows grazed on *Setaria sphacelata* var. Splendida estimated using the same technique was 14.42 kg/animal/day or 4.06% body weight/day.

It is concluded that by measuring the water turnover rate, water intake and water content of the feed, the dry matter intake of animals grazing on homogenous pasture can be estimated with high accuracy.

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