MEASUREMENT OF MILK CONSUMPTION IN YOUNG RUMINANTS USING TRITIATED WATER

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SUMMARY

Milk intakes for lambs and calves were calculated from water turnover rates following the injection of tritiated water. The validity of the method was confirmed for lambs and calves up to four weeks of age. The method was considered to be sufficiently accurate and simple for use in large experiments.

Techniques for measuring milk production in beef cattle and sheep include weighing animals before and after suckling (Coombe *et al.*, 1960; Brumby *et al.*, 1963) and the use of oxytocin (McCance, 1959; Lamond *et al.*, 1969).

Errors in weighing, separation of the mother and young, carry-over effects of oxytocin injection on the rate of milk secretion, and difficulty in handling untrained beef cows, are criticisms which have been made of the above methods (Sprain *et al.*, 1954; Donker *et al.*, 1954; Yates *et al.*, 1971).

Nicol and Irvine (1973) have described an isotope dilution method using two iodine isotopes for use with suckling beef calves. While their method overcomes the objection to using oxytocin, considerable animal handling is necessary as well as separation of the calf from the cow for six hours.

Macfarlane *et al.* (1969) have used tritiated water turnover as a measurement of milk intake in young ruminants. This method is based on the principle that lambs or calves obtain water entirely from milk in the first weeks of life and by measuring the rate at which an injection of tritiated water (TOH) is diluted over periods of days or weeks, an assessment of milk intake becomes possible.

Since milk intake is a critical factor in the early growth of lambs or calves, we have tested the validity of the use of tritiated water in measuring milk intake.

METHODS

ANIMALS

Trial 1

Ten one-week-old lambs were penned indoors and fed individually from bottles twice daily with measured volumes of reconstituted milk containing 15% solids. At three weeks of age the lambs were put on pasture and bottle-fed for one week. Injections of tritiated water were given at one and three weeks of age. Lambs were weighed weekly.

Trial 2

Eight one-week-old calves were trained to drink from buckets containing measured quantities of fresh whole milk. The intake of milk was measured following each feed (7 a.m., 4 p.m.). The calves, which were kept on pasture, were injected with tritiated water when one, two, three and four weeks old and weighed following injection.

Trial 3

Sheep were drawn from a Templeton flock of purebreds and two-way crosses produced from Romney and Dorset breeds. The lambs were grouped for weekly injection with ages varying from one day to seven days at the first injection.

Four-hourly milk production in these ewes was measured with oxytocin on the same day as the lambs were injected with tritium.

Trial 4

Sixty calves from Friesian × Angus, Hereford × Angus or Angus cows which had been mated to an Angus bull were tested at Tokanui. The calves received their first injection usually within one day of birth.

MEASUREMENT OF BODY WATER TURNOVER

Animals were injected intra-muscularly with TOH in sterile 150 mM sodium chloride solution and blood samples taken after 2 to 3 h (Macfarlane *et al.*, 1969). Serum samples were processed either by sublimation or ethanol precipitation of proteins and counted in a liquid scintillation counter. The method of ethanol precipitation gave results identical to sublimation and enabled samples to be processed more quickly.

RESULTS

TRIAL 1

Calculation of Milk Intake from Water Turnover in Lambs

Calculation of milk intake from tritiated water turnover measurements during weeks 1-2 and 3-4 are shown in Table 1

TABLE 1: WATER TURNOVER AND MILK INTAKE IN LAMBS

Lamb No.	$\frac{TOH\ Turnover}{Milk\ Water^1} \times 100$ *Week 1-2*	*Week 3-4*[2]
1	101.3	114.7
2	108.6	102.8
3	97.4	105.2
4	125.3	137.3
5	115.2	105.4
6	105.8	101.2
7	107.9	94.2
8	90.5	94.0
9	143.7	110.7
10	105.0	115.5
Av.	110.0	108.1

[1] Milk water = 0.95 × milk volume.

[2] Lambs 4 and 9 were kept indoors, the rest were on pasture in week 3-4. Average for pasture-fed lambs = 104.1.

and compared with known milk intake. The water turnover over-estimated milk intake by 10% in the first period, and by 8% during the second period. Two lambs (4 and 9) which were poor feeders had excessively high values of 125.3 and 143.7, respectively, in the first experimental period.

In week 3-4 the eight lambs on pasture had turnovers only 4% greater than measured intakes with a range of values 94.0-115.5.

TRIAL 2

Calculation of Milk Intake from Water Turnover in Calves

For the first three periods, from the age of one week to four weeks the estimation of milk intake from water turnover in calves gave values of 96.6, 104.7 and 99.4% of known intake. Between the fourth and fifth week, this value was 129.4% (Table 2).

TABLE 2: WATER TURNOVER AND MILK INTAKE IN CALVES[1]

Period (weeks)	TOH Turnover / Milk Water[2] × 100 Average	Range
1-2	96.6	83-106
2-3	104.7	89-115
3-4	99.4	87-117
4-5	129.4	120-145

[1] Calves were bucket-fed whole milk and kept on pasture.
[2] Milk water = 0.95 × milk volume.

TRIAL 3

Water Turnover in Lambs and Milk Production in Ewes

The water turnover in 39 lambs from four different dam breeds was measured during the first three weeks of age, and is compared with milk production in Table 3.

TABLE 3: WATER TURNOVER IN LAMBS AND MILK PRODUCTION IN EWES

Dam Breed	No	TOH Turnover / Milk Water[1] × 100 Week 1	Week 2	Week 3
Dorset	9	56.1	79.2	96.3
Romney	9	81.7	100.7	132.3
Dorset-Romney	12	69.6	83.9	116.3
Romney-Dorset	9	67.5	90.1	102.9
All	39	67.2	86.0	110.8

[1] Milk water = 0.95 × milk volume.

Water turnover increased for all lambs from 1.18 l/d to 1.94 l/d in the third week. Lambs from Romney or Romney-Dorset ewes had smaller turnovers than lambs from Dorset or Dorset-Romney ewes. The average milk production for all ewes was constant during the three weeks.

The intake of milk is less than the milk available during the first two weeks, the averages being 67.2 and 86.0% for weeks 1 and 2, respectively. By week 3, the calculated intake was 10.8% greater than milk production measurements.

TRIAL 4

Water Turnover in Calves

The water turnover in sixty calves from Angus, Friesian-Angus or Hereford-Angus is shown in Table 4. In all breeds

TABLE 4: WATER TURNOVER IN CALVES

Dam Breed	*No.*	*Water Turnover (l/d)* *Weeks 0-1*	*Weeks 2-4*	*Body Weight Gain (kg)* *0-4 Weeks*
Angus:				
Male	6	4.1	6.5	21.5
Female	15	4.0	5.3	20.0
Friesian-Angus:				
Male	15	5.1	8.0	28.4
Female	7	4.8	7.0	26.7
Hereford-Angus:				
Male	7	4.5	6.4	22.6
Female	9	4.0	5.7	21.4

the water turnover was greater in the male calves. Highest values were found in Friesian-Angus calves which also had the highest birth weight (31.1 kg) and greatest four weekly gain in body weight. The Angus and Hereford-Angus calves did not show any large breed difference.

DISCUSSION

Use of Tritiated Water

The present experiments confirmed the validity of using water turnover rates calculated from the dilution rate of tritiated water injected into lambs or calves, as a method for estimating milk intake. In these experiments the calculated turnovers were only slightly in excess of known intake. However, it was observed that two of the lambs (numbers 4 and 9, Trial 1) were poor drinkers in both experimental periods and their calculated intakes were excessively high.

Calves also gave close agreement in the first three periods up to four weeks of age, the intake of water from pasture apparently having little effect on water turnover measurements. Between the fourth and fifth weeks all the calves had calculated intakes much greater than known intake, presumably because of intake of pasture.

Ewe Milk Production

Milk production in ewes calculated from 4 h test periods assumes that the rate of milk secretion during this period is typical of that during one week and measures the quantity of milk a lamb could drink in that time. It does not necessarily measure the quantity of milk taken by the lambs as is shown in Trial 3. During the first week of this experiment

the estimated milk intake was considerably less than the ewes' milk production. However, by week 2 the calculated intake was very close to the measured milk production.

Work by Geenty and Jagusch (1974) at Templeton showed that milk production of the Dorset was higher than that of the Romney. In Trial 3, the values from water turnover and milk production also showed large differences between these two breeds, the Dorset producing better than the Romney. This breed difference was reflected in the higher water turnover in the Dorset lambs and a faster growth rate.

In Trial 4 at Tokanui water turnover is greatest for Friesian × Angus calves which had the greatest weight gain in the 4-week test period. In all breeds the male had a higher turnover and faster weight gain than the female calves.

CONCLUSIONS

These trials confirmed the validity of using water turnover rates calculated from the dilution rate of tritiated water injected into lambs or calves to estimate milk intake. The technique of using water turnover measurements was regarded as sufficiently accurate and simple to permit large experiments. However, more data would be required to establish breed differences.

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