

STUDIES ON THE METABOLISM OF NITROGENOUS COMPOUNDS IN THE RUMEN I. METHODS OF ESTIMATION OF THE WHOLE RUMEN CONTENTS BY PLUGGING OF THE RETICULO-OMASAL ORIFICE

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STUDIES ON THE METABOLISM OF NITROGENOUS COMPOUNDS IN THE RUMEN

I. METHODS OF ESTIMATION OF THE WHOLE RUMEN CONTENTS BY PLUGGING OF THE RETICULO-OMASAL ORIFICE

By

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It has been suggested that the protein and the other nitrogenous compounds are degraded by the vast numbers of ruminal micro-organisms in the process of the ruminant digestion (1—7). Ruminal micro-organisms breakdown the protein to the amino acids and the peptide. These amino acids and the other nitrogenous compounds may be fermented to ammonia and volatile fatty acids (8—13). Ammonia and other end products of fermentation can be utilized by ruminal micro-organisms and be made up to their own body protein (14—17).

The processes of the degradation of feed protein and the resynthesis to the micro-organisms protein are carried out simultaneously in the rumen. Therefore, the amount of the whole protein in the rumen will decrease or increase depending on the results of protein degradation and resynthesis of it from other nitrogenous compounds. It is very worthwhile to observe the fluctuation of the net protein amount in the rumen, for the sake of ruminants nutrition and for the decision of feed protein quality. However, many difficulties are present to observe the fluctuation of net protein contents in the rumen ingesta *IN VIVO* (16—18).

These difficulties are due to following reasons.

1) The weight of whole rumen contents is difficult to know at any given time.

2) The rumen contents flow out through the reticulo-omasal orifice into the omasum, and the rumen contents lose its weight continuously.

In order to give a solution to these difficulties, surgical and instrumental techniques were devised. The work described in this paper was the surgical

and instrumental techniques for weighing the rumen contents under the condition of the reticulo-omasal orifice blocking.

Procedure and Results

A sheep weighing 28 kg in body weight was employed. A large permanent rumen fistula was made by surgical operation. The reticulo-rumen contents (hereafter this is described as rumen contents for simplicity) were removed perfectly through the large rumen fistula which had 9--10 cm in diameter (plate 1), and were returned again into the rumen immediately. The large permanent rumen fistula was closed with the cannula consisted of plastic plate and foam rubber (plate 2). By repetition of this procedure, weighing the amount of the whole rumen contents and taking a sample truly representing the concentration of ingredient of the whole rumen contents were possible at any given time.

The rumen contents flow out into the omasum and diminish continuously from the rumen. By the blocking of the flow out of the rumen contents through the reticulo-omasal orifice, the net fluctuation of the nitrogenous compound in the rumen could be estimated. For the purpose of blocking of the rumen contents flow out through the reticulo-omasal orifice, a reticulo-omasal orifice plug was devised (plate 3). As shown in plate 3 the reticulo-omasal orifice plug had a club shaped top, a disk plate at the other end and an axis connecting them. This plug was made from brass. The axis was surrounded with foam rubber. This plug 30 mm in diameter and 55 mm in length for the reticulo-omasal orifice of the sheep weighing 28 kg in body weight. The club shaped top of the reticulo-omasal orifice plug was inserted into the omasum from the rumen through the rumen fistula by the hand. Then the axis of the plug which was just placed in the reticulo-omasal orifice, was covered with foam rubber to prevent the leakage of rumen contents from reticulum to omasum. In the next step, the end plate was screwed in the plug to avoid the fall drop of the plug into the omasum. In order to examine whether an omission of the rumen contents into the omasum took place, the recovery experiments of Cr_2O_3 and polyethyleneglycole in the rumen was performed under the reticulo-omasal orifice blocking condition.

Cr_2O_3 recovery :

The whole rumen contents were removed perfectly through the rumen fistula with a polyethylene cup immediately after the morning feeding, then the reticulo-omasal orifice plug was inserted into the reticulo-omasal orifice. The removed whole rumen contents were weighed and mixed with 10 g Cr_2O_3 and about 50 g rumen contents of the sample for analysis were taken. After finishing these procedure, the removed rumen contents were returned into the rumen and rumen

fistula was closed by a plastic plate with the foam rubber cannula above mentioned. Hereafter, the animal was maintained in fasting throughout the experimental period. The fluctuation of the rumen contents weight and recovery rate of Cr_2O_3 in the reticulo-omasal orifice plugged animal under the condition of five different kinds of feeding is shown in Table 1. The Cr_2O_3 determination was performed by the method of Schürch *et al.* (19). The recovery of Cr_2O_3 in the rumen was 97.7 per cent in nine hours as the average value.

Table 1. Weight change of rumen contents and recovery rate of Cr_2O_3 in the rumen of a sheep, 28 kg in body weight, whose reticulo-omasal orifice was plugged.

Time after beginning of feeding (hr)	Experimental ration					
	(A)		(B)		(C)	
	Weight of rumen contents (g)	Recovery rate of Cr_2O_3 (%)	Weight of rumen contents (g)	Recovery rate of Cr_2O_3 (%)	Weight of rumen contents (g)	Recovery rate of Cr_2O_3 (%)
2	4460	100.0	4170	100.0	4730	100.0
5	5000	97.0	4510	93.7	5005	101.3
11	4975	94.3	4570	93.7	4745	97.0
	(D)		(E)		mean	
Time after beginning of feeding (hr)	Weight of rumen contents (g)	Recovery rate of Cr_2O_3 (%)	Weight of rumen contents (g)	Recovery rate of Cr_2O_3 (%)	Recovery rate of Cr_2O_3 (%)	
2	7100	100.0	6700	100.0		
5	7170	98.9	6300	99.8	98.1	
11	7090	100.5	6010	103.1	97.7	

(A) : Orchard hay

(B) : Orchard hay, Soybean oil meal

(C) : Ladino clover (green fodder)

(D) : Corn ensilage

(E) : Soybean oil meal, Wheaten bran

Polyethylene glycole recovery :

The similar experiments were performed using polyethylene glycole (P.E.G.) as an indicator. The whole rumen contents of the sheep were removed perfectly after 24 hours fasting and the reticulo-omasal orifice plug was inserted into the reticulo-omasal orifice. Around 3.0–3.1 l saline solution in which 7 g of the P.E.G. were contained was poured into the rumen through rumen fistula. Seven hours later, the whole saline solution was withdrawn from the rumen through the rumen fistula and P.E.G. concentration was determined by the method of Hydén (20). The results (Table 2) show that the reticulo-omasal orifice plug can prevent almost completely the flow out of the aqueous rumen contents into the omasum.

Table 2. Weight change of saline solution and recovery rate of P.E.G. in the rumen of the sheep under the condition of reticulo-omasal orifice plugging

Time after infusion of saline solution (hr)	Experiment A		Experiment B	
	Weight of rumen fluid (g)	Recovery rate of P.E.G. (%)	Weight of rumen fluid (g)	Recovery rate of P.E.G. (%)
0	3100	100.0	3000	100.0
7	2755	98.8	5110	99.6

Saline solution: 0.1 mM potassium acetate

Discussion

The weight of the whole rumen contents and its fluctuation after feeding could be estimated by the method of taking off the rumen contents, weighing it and returning the remainder to the rumen through the fistula.

The time required for emptying the rumen, weighing the rumen contents and returning it to the rumen was about 10–15 minutes if the contents weight ranged from 3 to 7 kg. However, when these procedures were performed under the cold environment the animal showed shivering.

Since the rumen contents were exposed to air and to temperature lower than the body temperature, the returning rumen contents might have a somewhat different conditions. Therefore, these effects must be taken in consideration.

The results of recovery experiments of Cr_2O_3 and P.E.G. showed that the prevention of the flow out of the rumen contents into the omasum with the use of reticulo-omasal orifice plug, was almost complete. Even the fluid rumen contents flow out into the omasum by the plugging could also be stopped. This was confirmed by the recovery experiment of the P.E.G., in spite of the weight change of the rumen solution as shown in Table 2.

The reticulo-omasal orifice plug must be fit in its size and length to the width of the reticulo-omasal orifice of the animal used for the experiment. If the size of the reticulo-omasal orifice plug is not suitable to the width of the reticulo-omasal orifice of the experiment animal, it is difficult to obtain good results. If the plug is too large for the animal, it can not be inserted into reticulo-omasal orifice, and if the plug is too small, it will easily slip down from the reticulo-omasal orifice into the rumen or omasum during the experiment time.

The ruminal movement and the rumination were not disturbed markedly by the plugging of the reticulo-omasal orifice. However, plugging over 24 hours was not performed.

The weight of whole rumen contents increased at hours after feeding except

in the case of soybean oil meal and wheaten bran which concentrates only and with the exception of roughage. These weight increase of the rumen contents will be explained due to the inflow of saliva. Namely, it may be indicated that the volume of saliva flowed into the rumen exceeded the absorbed volume of any substances including water from the rumen in three hours after feeding.

Summary

1) The weight of whole rumen contents and its change at any given time after feeding was estimated with the method of taking out the rumen contents, weighing them, sampling from them and returning the remainder into the rumen through the rumen fistula.

2) In order to prevent the flow of the rumen contents into the omasum, a reticulo-omasal orifice plug was inserted into the reticulo-omasal orifice through rumen fistula. Indicator recovery method of Cr_2O_3 and P.E.G. showed that the flow out of the rumen contents into the omasum could be stopped completely over nine hours.

3) Under the reticulo-omasal orifice plugged condition, weight change of the rumen contents and method for sampling was determined.

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Explanation of Plate

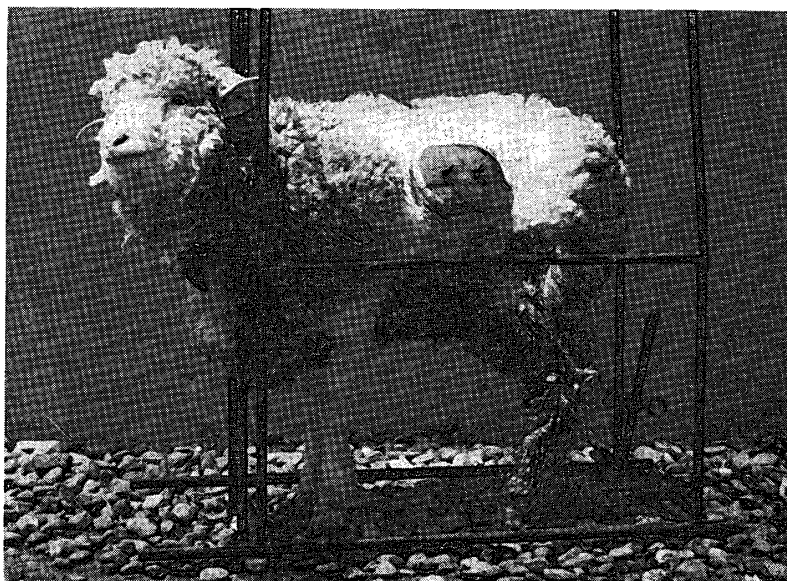


Plate 1. A large permanent rumen fistula fitted sheep. Fistula was closed by plastic plate and foam rubber cannula.

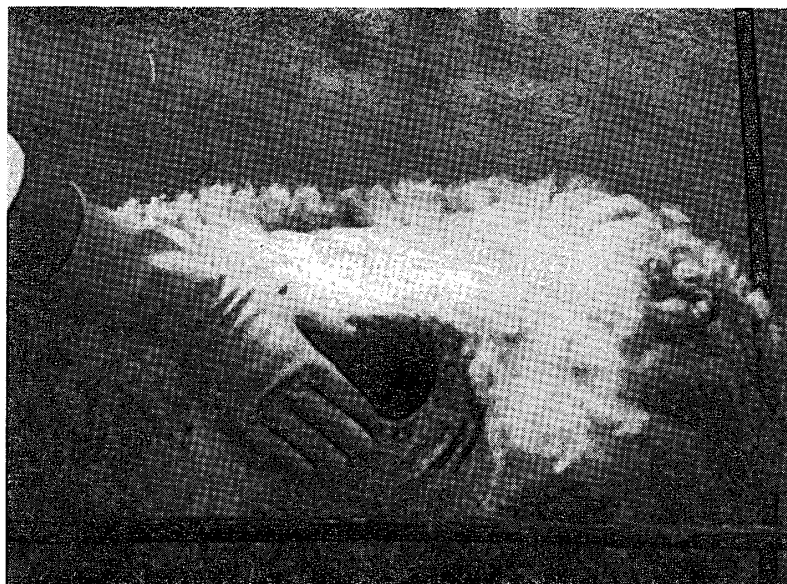


Plate 2. Cannula was removed and opened rumen fistula.

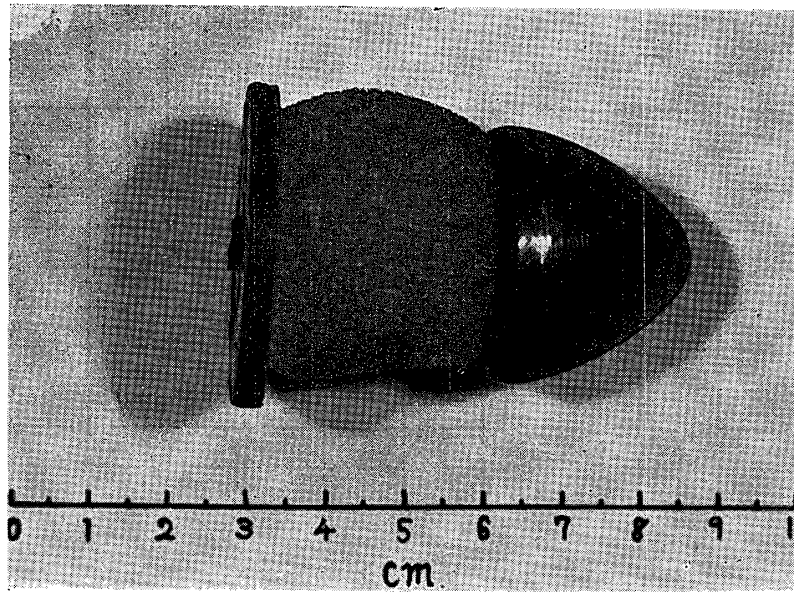


Plate 3. Reticulo-omasal orifice plug.