The Utilization of Casein Introduced into the Abomasum of Goats Fed a Basal Diet of Low-Quality Hay

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ヤギの第4胃内に投与されたカゼインの利用性について

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INTRODUCTION

Cuthbertson and Chalmers[1] and Chalmers et al.[2] reported with sheep that casein infused into the duodenum was utilized more effectively than that infused into the rumen. Reis et al.[3] found that the abomasal infusion of casein resulted in a considerable increase in wool growth of mature sheep.

According to Fujihara and Tasaki[4], abomasally-infused casein was utilized as effectively as ruminally-infused casein in goats fed a purified diet. Recently, Fujihara and Tasaki[5] also reported that the utilization of abomasally-infused casein (30 g/day/head) in goats orally fed a low-quality hay was 61～68%. In the present experiment, the effect of infusion level of casein into the abomasum on the nitrogen metabolism of goats fed a basal diet of low-quality hay.

EXPERIMENTAL PROCEDURE

Three castrated male Japanese Saanen goats weighing about 30 kg were used, and two of these goats were as described previously[5]. Each goat was fitted with permanent fistulas at the rumen and at the abomasum by means of the methods described by the author.[6] This study was composed of two experiments, and the procedures for each of experiments were as follows :

Experiment I : The goats were kept in metabolism cages throughout the experimental period of 30 days. The first 15 days was designated as a basal feeding period, and the second 15 days as a casein infusion period. The goats were fed 600 g of low-quality hay as a daily basal diet during the two experimental periods. The quantity of casein infused was 60 g a day. One-half of the daily dose of casein was suspended in 100 ml of warm water and infused into the abomasum through the abomasal fistula at a rate of 150 ml per hour using a speed-controlled injector. Feeding hay and abomasal infusion were performed twice a day at 9 : 00 hour and 17 : 00 hour. Feces and urine during the last 5 days in each period were collected, and nitrogen in the feeds, feces and urine was analyzed by the micro-Kjeldahl method.

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Experiment II : The goats were fed 550～570 g low-quality hay as a daily basal diet during the two experimental periods. The quantity of casein infused was 90 g a day. The other experimental procedures were similar to those of Experiment I.

RESULTS AND DISCUSSION

Experiment I : Apparent digestibilities of dry matter and crude protein, as well as nitrogen balance, are shown in Table 1. The digestibility of dry matter was increased by the abomasal infusion of casein, and this result was very similar to that of Fujihara and Tasaki[5] using goats. Since the casein digestibility was very high as described later, the increase in dry matter digestibility seems to be due to the better digestibility of casein infused.

Digestibility of crude protein increased largely with casein infusion in both goats. When 60 g of casein was infused into the abomasum, the digestibility of crude protein was 77.4 % and 74.2% in Goats A and B, respectively. These results were almost the same as that of Little and Mitchell[7] with wethers (78.5%) when 50 g of casein was administered abomasally. Based on the crude protein digestibility of basal diet, the digestibility of abomasally-infused casein was calculated as 86.5% and 89.0% in Goats A and B, respectively. These results were 10～15% higher compared with that of Fujihara and Tasaki[5] in which 30 g of casein was infused into the abomasum of goats, but were lower than that of Blaxter and Martin[8] with wethers (99.8%). As indicated in Table 1, the

Table 1. Apparent digestibility and nitrogen balance

Goat	A		B	
Feed intake (g/day)				
Hay, oral	600	600	600	600
Casein, abomasal	—	60	—	60
Digestibility (%)				
Dry matter	48.1	55.3	42.6	51.4
Crude protein	63.0	77.4	57.5	74.2
Casein*	—	86.5	—	89.0
Nitrogen balance (g/day)				
Intake,				
total	7.3	15.5	7.3	15.5
oral	7.3	7.3	7.3	7.3
abomasal	—	8.2	—	8.2
Excretion,				
total	6.7	12.9	6.8	12.5
fecal	2.7	3.8	3.1	4.0
urinary	4.0	9.1	3.7	8.5
Retention,				
total	0.6	2.6	0.5	3.0
from casein*	—	2.0	—	2.5
		(27.1)		(34.3)

* Calculated values based on the basal hay feeding. Values in parentheses show the efficiency of casein nitrogen retention indicated as percent of digested casein nitrogen.

digestibility of crude protein in basal hay feeding period was slightly higher in the present experiment than that of Fujihara and Tasaki[5], though the experimental animals were the same in both experiments. The high digestibility of casein in the present experiment may be due to the hightened activity of proteolytic enzymes in the post-ruminal alimentary tract of goats, because the hay as a basal diet contained more crude protein in the present experiment than in the previous experiment[5].

Fecal nitrogen output was slightly increased by 60 g of casein infusion, and the increased level was almost similar to that of Fujihara and Tasaki[5] in which 30 g of casein was infused into the abomasum of goats. Urinary nitrogen excretion was about twice as much higher in casein infusion period than in basal feeding period in both goats. As a result, 2.6～3.0 g of nitrogen was retained in the body, and these amounts corresponded to 22～25% of digested nitrogen. This result was slightly higher than that of Little and Mitchell[7] using wethers (19%). Based on the result of basal feeding period, the utilization of infused-casein nitrogen was calculated as 27～34%. The amount of retained-casein nitrogen was almost the same as that of Fujihara and Tasaki[5] when 30 g of casein was additionally infused into the abomasum of goats. Blaxter and Martin[8] reported that in fattening sheep, 86% of casein nitrogen abomasally infused was excreted into urine, and that most of the urinary nitrogen was excreted as urea and ammonia. Comparing the result of the present experiment with that of Blaxter and Martin[8] urinary nitrogen was smaller in the present experiment.

Experiment II : Table 2 shows apparent digestibilities of dry matter and crude protein as well as the nitrogen balance of the experimental goats. Dry matter digestibility was increased by the abomasal infusion of casein, and this result was very similar to that of Fujihara and Tasaki[5] and of Experiment I. Fujihara and Tasaki[9] also reported that dry matter digestibility was increased with abomasal infusion of soybean protein (110 g/day/head) in goats fed a low-quality hay. The increase in dry matter digestibility seems to be due to the better digestibility of casein infused, because the digestibility of casein infused was very high as described later.

The digestibility of crude protein increased markedly with casein infusion in both goats. When 90 g of casein was infused into the abomasum, crude protein digestibility was 75.6 % and 82.5% in Goats B and C, respectively. These figures were almost similar to those of Experiment I (74～77%) when 60 g of casein was infused abomasally. The calculated digestibility of casein infused was 88.6% and 95.1% in Goats B and C, respectively. These results were slightly higher compared with that in Experiment I when 60 g of casein was infused into the abomasum of goats, but lower than that of Blaxter and Martin[8] with wethers (99.8%). Ukai[10] also reported that the true digestibility of crude protein was 93.4～98.7% in goats when 100 g of casein was introduced into the abomasum. From these results mentioned above, it is suggested that goats are capable of digesting casein in the post-ruminal alimentary tract when a large amount of casein was directly introduced into the abomasum.

Fecal nitrogen output was slightly increased by 90 g of casein infusion, and the increased level was almost similar to that of Experiment I when 60 g of casein was infused into the abomasum. Urinary nitrogen excretion was about 3.5 times as much higher in casein infusion period than in basal feeding period in both goats. As a result, the retained

Table 2. Apparent digestibility and nitrogen balance

Goat	B		C	
Feed intake (g/day)				
Hay, oral	570	570	550	550
Casein, abomasal	—	90	—	90
Digestibility (%)				
Dry matter	42.3	58.1	59.0	69.3
Crude protein	59.3	75.6	62.8	82.5
Casein*	—	88.6	—	95.1
Nitrogen balance (g/day)				
Intake,				
total	8.1	20.4	7.8	20.1
oral	8.1	8.1	7.8	7.8
abomasal	—	12.3	—	12.3
Excretion,				
total	7.5	17.3	6.1	16.5
fecal	3.3	4.7	2.9	3.5
urinary	4.2	12.6	3.2	13.0
Retention,				
total	0.6	3.1	1.7	3.6
from casein*	—	2.5	—	1.9
		(22.9)		(16.2)

* Calculated values based on the basal hay feeding. Values in parentheses show the efficiency of casein nitrogen retention indicated as percent of digested casein nitrogen.

nitrogen was 3.1～3.6 g/day per head, and these amounts corresponded to 20～22% of digested nitrogen. This result was almost similar to that of Experiment I. Based on the result of basal feeding period, the utilization of infused-casein nitrogen was calculated as 16～22%, and this figure was about 10% lower than that of Experiment I. As described previously, Blaxter and Martin[8] observed with fattening sheep that most of casein nitrogen abomasally infused was excreted into urine. The finding in the present experiment was almost similar to that of Blaxter and Martin[8]. From the results mentioned above, it may be suggested that there are certain limits on nitrogen retention of ruminants in abomasal feeding as well as in ruminal feeding.

SUMMARY

The experiment presented here was undertaken to investigate the effect of infusion level of casein into the abomasum on the nitrogen metabolism of goats fed a basal diet of hay. The following results were obtained.

1. The calculated casein digestibility was 86.5～89.0% when 60 g of casein was administered into the abomasum, and the retention of casein nitrogen was 2.0～2.5 g per day. The utilization of infused-casein nitrogen was calculated as 27～34%.

2. When 90 g of casein was additionally infused into the abomasum, the digestibility of casein was calculated as 85.6～95.1%. As a result, 1.9～2.5 g of infused-casein nitrogen was retained in the body, and the calculated utilization of casein nitrogen was 16～22%.

These results suggest that there is a certain limit on nitrogen retention when more nitrogen than the requirement is provided.

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摘　　要

種々の窒素栄養源をヤギの第4胃内に直接投与した場合の，その利用性に関する一連の研究の中で，カゼインを1日1頭当たり 30g 投与した時のその利用性については既に報告したが，本試験は更にカゼインの投与量を増加した場合のその利用性の変化と，それが窒素代謝に及ぼす 影響について明らかにするために行われたものである．去勢成雄ヤギ3頭を供試し，カゼインの投与量は1日1頭当たり 60g および 90g とした．その結果次の事が明らかになった．1：乾草のみを給与した時の値を基にして得られたカゼインの消化率は，1日1頭当たり 60g 投与の場合，86.5～89.0% であった．カゼイン由来の窒素の 蓄積量は 1日1頭当たり 2.0～2.5g であり，これは消化されたカゼイン窒素量の27～34%に相当した．2：1日1頭当たり 90g のカゼインを投与した場合，カゼイン消化率の計算値は86.5～95.1%であった．カゼイン窒素の蓄積量は1日1頭当たり 1.9～2.5g であり，この量は吸収されたカゼイン窒素量の16～22%に相当した．これらの結果から，反芻動物においては，第1胃内投与の場合と同様に第4胃内投与の場合においても，窒素の蓄積量に関して一定の限界があることが示唆された．