RESPONSES TO POST-RUMINAL INFUSION OF CASEIN AND GLUCOSE IN LACTATING GOATS

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Summary

Lactating goats fed a basal ration containing 11% crude protein, were infused intra-abomasally with 45g/d of either casein or glucose, in an attempt to determine whether milk production responsesto casein infusions could be attributed to gluconeogenesis from the casein. Infusions of casein increased the production of milk and milk constituents whereas the-production during glucose infusions was similar to that on the basal ration. Milk fat content was depressed by the glucose infusion. The output of nitrogen in milk and urine was increased during the casein infusion. Consideration of the data from this and other similar experiments leads us to conclude that the production response to casein infusion post ruminally, cannot be attributed to an increased availability of glucose precursors.

I. INTRODUCTION

Feeding standards for lactating ruminants are based on apparently digestible crude protein (DCP). The intake of DCP, however, often bears little relationship to the actual amino acid supply (Satter and Roffler 1974). A number of workers have reported that postruminal infusion of casein leads to increased milk production in cows fed rations containing levels of crude protein considered adequate by accepted feeding standards (Clark, Spires and Derrig 1973; Vik-Mo, Emery and Huber 1974). Recently, we obtained similar results with lactating goats in which successive increments in milk production were recorded following intra-abomasal infusions of increasing levels of casein (Ranawana and Kellaway 1975). It is well recognised that glucose is a key nutrient in milk synthesis (Linzell and Peaker 1971) and that amino acids are major precursors of glucose in ruminants (Wolff and Bergman 1972). The present study was carried out to examine the extent to which increases in milk yields following casein infusions could be attributed to increased gluconeogenesis in response to the extra supply of absorbed amino acids. .

II. MATERIALS AND METHODS

Three, multiparous Saanen does, in mid-lactation, of similar live weight and milk production, were used for the experiment, Details of surgical and management procedures have been described in an earlier paper (Ranawana and Kellaway 1975). The basal ration contained 62% rolled barley, 20% lucerne chaff, 10% oat straw, 7% molasses and 1% bone meal. On analysis it was found to contain 87.9% dry matter, 11.2% crude protein, 17.9% acid detergent fiber and 4.8% lignin. The daily allowance was divided into eight equal portions and offered every three h, using an automatic feeder.

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The three goats were assigned at random to three treatments in ‚a
3 x 3 Latin square such that each goat was subjected to each treatment for
a period of 14 d. Within each period, the goats were allowed seven d to
adjust after which measurements were made for five d to estimate milk
yield and nitrogen balance. The treatments consisted of a control (no
infusion) and infusions into the abomasum of 45 g/d of either glucose or
casein. The glucose infusate contained **50** g/l of glucose, 62.5 mg/l **di-
hydro** streptomycin sulphate and **62,500** units/l penicillin G. The composi-
tion of the **casein** infusate and details of the infusion procedures have
been described previously (Ranawana and Kellaway **1975).** During the
appropriate period, the goats received as a constant infusion **900** ml/d of
infusate which was equivalent to 45 g of either glucose or **casein.**

Details of the collection, sampling, storage and analysis of milk,
feed, faeces, urine and the **infusate have** been described previously
(Ranawana and Kellaway **1975).** The data were submitted to a conventional
Latin square analysis and the treatment means were subjected to **Duncan's**
new Multiple Range Test to assess significant differences (Steel and
Torrie **1960).**

<center>III. RESULTS</center>

One goat refused **60** g/d of the basal ration when infused with **casein**
and 330 g/d during the glucose infusion. As these seemed to be her **max-
imum** intakes and she appeared to be in good health, the data are included
in the results. The effects of-infusions on the production of milk and
milk constituents are shown in the table.

**Production of milk and its constituents together with nitrogen balance
data on the control diet and during infusion of casein or glucose**

	Milk data					Nitrogen balance data			
	Con.	Cas.	Glu.	SEM		Con.	Cas.	Glu.	SEM
	Milk yield					Nitrogen intake (g/d)			
g/d**	1587^a	1862^b	1621^a	30.9	Basal	35.81	35.44	33.81	1.06
	Total solids				Total*	35.81^a	41.48^b	33.81^a	1.06
% (w/v)	13.47	13.53	12.52	0.34		Nitrogen output (g/d)			
g/d**	213.1^a	250.7^b	202.7^a	4.80	Faeces	9.52	9.69	9.38	0.29
	Milk fat				Urine*	12.62^a	17.36^b	13.29^a	0.89
% (v/v)*	4.65^a	4.35^{ab}	3.83^b	0.20		Productive nitrogen (g/d)			
g/d*	73.7^{ab}	80.5^a	62.1^b	3.57	Total	13.67	14.43	11.14	0.92
	Solids-non-fat				Milk**	8.40^a	10.04^b	7.96^a	0.19
% (w/v)	8.82	9.18	8.69	0.16	Retained	5.29	4.39	3.18	1.82
g/d**	139.4^a	170.3^b	140.7^a	2.37		Nitrogen absorbed (g/d)**			
	Lactose					26.29^a	31.79^b	24.43^a	0.80
% (w/v)	4.85	4.90	4.85	0.04		Nitrogen digested (%)**			
g/d*	76.7^a	91.0^b	78.5^a	2.38		73.4^a	76.6^b	72.3^a	0.25
	Total protein								
% (w/v)	3.39	3.46	3.14	0.10					
g/d**	53.8^a	64.4^b	50.9^a	1.18					
	Casein				Values with different superscripts			
% (w/v)	2.74	2.83	2.50	0.12	differ significantly (**P<0.01;			
g/d**	43.2^a	52.4^b	40.5^a	1.72	* P<0.05)			

Relative to the control, milk production was significantly (P<0.01) increased during the infusion of **casein** but not glucose. Fat content of milk was **depressed by** the glucose infusion (P<0.05) whereas the slight depression during the **casein** infusion was not significant (P<0.05). The production of other milk constituents paralleled the increase in total milk production. ,

The nitrogen balance data are presented in the table. All the infused **casein** apparently was absorbed since there was no increase in faecal nitrogen output, resulting in a significant (X0.05) **increase in** nitrogen digested and absorbed. Although milk nitrogen was increased (P<0.05) by the **casein** infusion, most of the excess nitrogen absorbed from the **casein** was excreted in the urine. The goats were in positive nitrogen balance on the basal ration and the quantities of nitrogen retained were unaffected by either infusion. 'Glucose infusions had no effect on any of the nitrogen balance measurements.

IV. DISCUSSION

Annison and **Linzell (1964)** showed that 60 to 85% of the glucose entering the circulation of the high yielding goat is utilised by the mammary gland. Since little glucose as such is absorbed by the ruminant intestine (Leng 1970) the glucose requirement of the lactating mammary gland is met largely by gluconeogenesis from various dietary precursors. Although propionate is the chief substrate utilised; Wolff and Bergman (1972) showed in sheep fed a lucerne ration containing 20% crude protein, that 11 to 30% of the'glucose entering the circulation originated from amino acids. The 45 g of glucose infused in the present experiment would have supplied approximately 11% of the daily glucose turnover (Annison and **Linzell** 1964).

Although intravenous (**Linzell** 1967) or intraarterial (**Mepham** and ⋅ **Linzell** 1974) infusion of glucose increases milk yield in goats, evidence that post-ruminal infusion of glucose stimulates milk yield in lactating ruminants, is equivocal. Thus, Clark, Spires and Derrig (1973) reported that post-ruminal infusion of **casein** but not glucose stimulated milk production in cows. In contrast, Vik-Mo, Emery and Huber (1974) found in one of several experiments where glucose and **casein** were infused **post-ruminally,** that milk yield was stimulated equally by **casein** and glucose. They suggested that the response to glucose infusion was due to a sparing action on amino acids. However, it seems doubtful that this would occur since the amino acids likely to be spared (alanine, aspartate, **glutamine, glycine** and serine - Wolff and Bergman 1972) appear to be relatively unimportant for milk protein synthesis. It is, clear from the results of the present study that the intraabomasal infusion of glucose was without effect on the level of milk production. This finding leads us to suggest that where a production response to infusion of glucose has been obtained, the mechanism involved differs from that by which **casein** infusion stimulates milk yield. Consistent with this suggestion is the report of **Tyrell** et al (1972) that when **casein** was infused into **the** abomasum of lactating cows, 48% of the total energy infused appeared in milk. In contrast, the corresponding figure for glucose infusion was 16%.

The depression in fat content of milk in the present study is consistent with the results of several previous studies (**Fisher** and Elliot **1966; Clark,** Spires and Derrig 1973; Vik-Mo, Emery and Huber 1974). The depression of milk fat levels is apparently caused by the lowering of

levels of blood-borne precursors of milk fat and, thus, a reduced mammary extraction of these metabolites (Annison, Bickerstaffe and Linzell 1974).

Nitrogen balance data were presented to demonstrate the nitrogen. status of the goats in the present study.. The results obtained are similar to those of Clark, Spires and Derrig (1973) who reported that infusion of casein in cows increased the output of nitrogen in milk and urine. However, utilisation of absorbed nitrogen from casein in the present study, was poor when compared to the results of an earlier experiment (Ranawana and Kellaway 1975). This could be due to the fact that in mid-lactation utilisation of nutrients is less efficient than in early lactation.

In conclusion, it appears that the response in milk production to post-ruminal infusion of casein is not due to the provision of glucogenic amino acids. The possible mechanisms by which the response is elicited have been discussed by Clark (1974) who pointed out that the factors involved have not been resolved. A fuller understanding of the nature of the response would lead to optimum use of scarce-animal feedstuffs for milk production.

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