

## FATTY ACID DIGESTION AND UTILIZATION BY DAIRY COWS

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Efficiency of energy utilization for milk production depends not only on the proportion of volatile fatty acids produced from fermentation within the rumen but also on the balance of major nutrients absorbed from the small intestine, particularly long chain fatty acids (Kronfeld, 1976 ; Bines *et al.*, 1978). Because of microbial synthesis of long chain fatty acids in the rumen the amount of fatty acids flowing in the small intestine may exceed considerably the amount of fatty acids contained in the diet. Studies with sheep suggest that intraruminal synthesis of fatty acids may be affected by the level of feeding, the proportions of hay and concentrates, and the fat content of the diet (Sutton *et al.*, 1970).

In the present experiment intraruminal synthesis and intestinal absorption of long chain fatty acids have been studied in lactating cows fitted with re-entrant duodenal cannulae sited anterior to the point of entry of the bile and pancreatic ducts. The cows were given diets of hay and concentrates, based on rolled barley or ground maize, and comprising 60 or 90 per cent of the diet.

### Methods

Details of animals, diets, sampling and experimental design were as described (Experiment 1) in the communication of Oldham *et al.* (1979). Total and individual fatty acids in

feed, duodenal digesta and faeces were determined according to Bines *et al.*, (1978).

Intake, duodenal flow and faecal excretion of total, C<sub>14</sub>, C<sub>16</sub> and C<sub>18</sub> fatty acids were calculated for each of 4 cows on each diet and the data analysed statistically according to the design of a 4 × 4 Latin Square. Amounts of fatty acids apparently digested post ruminally were determined by subtracting faecal output from duodenal flow. Estimates of endogenous losses and true digestibilities of fatty acids were obtained from the intercepts and slopes of regressions of fatty acids apparently digested against duodenal flow.

### Results

Diets containing maize and barley in the same proportions provided very similar fatty acid intakes (table 1). In the diets containing maize, the amounts of C16 and total fatty acids were higher where concentrates comprised 90 % of the dry matter intake (P < 0.05). When averaged over diet types, the higher concentrate diets tended to provide higher intakes of fatty acids, but these differences were not significant (table 2).

On all diets, flows of fatty acids at the duodenum exceeded corresponding dietary intakes. The difference between intake and duodenal flow, apparent intraruminal synthesis, increased with carbon chain length of fatty

acid and was particularly marked for the C<sub>18</sub> acids (table 3). Maize supported a greater intraruminal synthesis of fatty acids than barley whereas the hay : concentrate ratio had little effect (tables 3 and 4).

When amounts of fatty acids apparently digested post ruminally were related to corresponding duodenal flow, significant linear relationships were found for all acids (table 5). High values for true digestibilities were obtained (range 83-100 %) with no apparent effect of diet or of fatty acid chain length.

## Discussion

The present data from dairy cows confirms our previous work with sheep that most of the

increased flow of fatty acid at the duodenum was due to C<sub>18</sub> fatty acids. In addition, we have been able to show that concentrate type is more important than concentrate proportion in influencing the rate of intraruminal fatty acid synthesis. The effect of concentrate type on fatty acid synthesis is particularly interesting in view of the fact that an opposite effect was found for protein synthesis (Oldham *et al.*, 1979). This aspect clearly requires further investigation.

The high true digestibility coefficients for fatty acids and the estimates of endogenous losses are very similar to those we previously reported for dairy cows given hay and concentrate diets (25 : 75) supplemented with large amounts of protected tallow (Brumby and Welch, 1978).

*Table 1.* — Intakes of dry matter (kg/d) and fatty acids (g/kg dry matter intake/day) by dairy cows given diets of hay with concentrates based on rolled barley (B) or ground maize (M) and comprising either 60 % or 90 % of the intake.

	Diet				SEM 6 d.f.
	60B <sup>+</sup>	60M	90B	90M	
Dry Matter	12.7	12.4	12.1	11.9	0.14
C14 $\emptyset$	0.12	0.07	0.12	0.06	0.006
C16	3.47	3.05	3.89	4.25	0.275
C18	7.60	6.28	9.32	10.84	1.508
Total fatty acids	13.32	11.91	14.96	17.98	1.685

+ : Diets described in the table title ;  $\emptyset$  : Sum of fatty acids with the number of carbon atoms designated.

*Table 2.* — Average effects of concentrate type, rolled barley (B) or ground maize (M), and proportion, 60 % or 90 %, on intakes of dry matter (kg/day) and fatty acids (g/kg dry matter intake/day) by dairy cows.

	Concentrate type		Concentrate proportion		SEM 6 d.f.
	B <sup>+</sup>	M	60	90	
Dry matter	12.4	12.2	12.6	12.0	0.10
C14 $\emptyset$	0.12	0.06***	0.09	0.09	0.004
C16	3.68	3.65	3.26	4.07	0.194
C18	8.46	8.56	6.94	10.08	1.066
Total fatty acids	14.14	14.95	12.61	16.46	1.192

+ : averages for diets described in the table title ;  $\emptyset$  : see table 1 ; \*\*\* : see table 4.

Table 3. — Difference between duodenal flow and dietary intakes of fatty acids in cows given hay with barley or maize in two proportions (g/kg dry matter intake/day).

Fatty Acid $\emptyset$	Diet				SEM 6 d.f.
	60B*	60M	90B	90M	
C14	0.27	0.49	0.75	0.57	0.063
C16	0.44	1.21	1.26	0.69	0.241
C18	3.69	11.70	3.52	11.18	1.371
Total fatty acids	5.45	13.82	7.00	13.05	1.307

$\emptyset$ , + : see table 1.

Table 4. — Average effects of concentrate type and proportion on the difference between duodenal flow and dietary intakes of fatty acids in cows (g/kg dry matter intake/day).

Fatty acid $\emptyset$	Concentrate type		Concentrate proportion		SEM 6 d.f.
	B*	M	60	90	
C14	0.51	0.53	0.38	0.66**	0.044
C16	0.85	0.95	0.83	0.98	0.171
C18	3.61	11.44**	7.70	7.35	0.970
Total fatty acids	6.23	13.43**	9.63	10.03	0.924

$\emptyset$  : see table 1 ; + : see table 2 ; \* , \*\* , \*\*\* : differences between concentrate type or proportion significant at  $P < 0.05$  ;  $P < 0.01$  ;  $P < 0.001$  respectively.

Table 5. — Relationship (g/kg dry matter intake/day) between duodenal flow — faecal flow of fatty acid (Y) and duodenal flow of fatty acid (X) in cows given barley or maize in two proportions\*  
 $Y = a + bX$

Fatty acid $\emptyset$	a	b	SE <sub>b</sub>	r	P (14 d.f.)
C14	- 0.16	0.829	0.069	0.955	***
C16	- 1.19	1.000	0.097	0.940	***
C18	- 0.68	0.880	0.062	0.969	***
Total fatty acids	- 3.677	0.908	0.067	0.964	***

+ ,  $\emptyset$  : see table 1 ; \*\*\* : slope significant at  $P < 0.001$ .

#### References

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