THE INFLUENCE OF A PROTECTED TALLOW SUPPLEMENT ON MILK YIELD AND COMPOSITION

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SUMMARY

Thirty Friesian cows in early lactation were fed a basal diet of pasture and maize silage together with one of three dietary supplements: dried lucerne chaff (C); dried lucerne chaff mixed with a formaldehyde-treated tallow and soybean supplement, containing 45% fat (HI-EN); and dried lucerne chaff mixed with ground barley meal (B), to provide an equal amount of energy to that supplied by diet HI-EN.

No significant treatment differences in milk yield were observed over the three-week feeding period. Cows fed HI-EN produced milk with a higher fat content than those fed diets B or C, and also yielded more fat than those fed diet C. About 24% of the supplemental fat appeared as long chain fatty acids in milkfat but, because mammary gland synthesis of short chain fatty acids (C_4-C_{14}) was depressed the extra milk fat produced was equivalent to only 17% of the fat in the supplement.

Cows fed diet B produced milk with a higher protein content than those fed HI-EN.

INTRODUCTION

The incorporation of a large quantity of oil or fat in rations to provide a concentrated source of energy for ruminants has met with only limited success. Voluntary feed intake, and the digestibility of dry matter and energy, may be reduced if dietary lipid levels exceed 8 to 10% (Chandler *et al.*, 1968).

In dairy cattle, the effect of dietary lipids on milk yield and composition depends on the balance between increased transfer of dietary fatty acids to milk and decreased intramammary synthesis of fatty acids (Storry *et al.*, 1973). This decrease in intramammary synthesis may be brought about by a lowered intake, changes in ruminal fermentation, or by inhibition of acetyl CoA carboxylase within the mammary gland (Steele *et al.*, 1971). Dietary lipids have often induced a decrease in the acetate: propionate ratio in the rumen (Storry *et al.*, 1974a) and increased propionate levels in the rumen have been implicated in the low milkfat syndrome (Davis and Brown, 1970; Annison *et al.*, 1974).

The protection of dietary lipids from ruminal fermentation by treatment with formaldehyde provides a mechanism for increasing

the level of energy intake, while preventing changes in rumen fermentation which may result in decreased intramammary synthesis of short chain fatty acids (Storry *et al.*, 1974a, b).

This study was designed to investigate the influence of a protected high energy supplement containing 45% fat upon milk yield and composition of dairy cows in early lactation.

MATERIALS AND METHODS

Animals and Feeding

Thirty Friesian cows of mixed age and in their first two months of lactation were allocated by calving date and milk yield to three treatment groups. All cows were grazed at pasture and fed 13.6 kg maize silage and 1.8 kg ground barley meal per head per day for a two-week preliminary period (June 17 to 30, 1974).

During the three-week experimental period, the animals received pasture (6.5 kg/head/day) and maize silage (4.5 kg/head/day), and were group fed one of three dietary supplements, after the afternoon milking. The supplements were: C—control treatment of dried lucerne chaff (1.25 kg/head/day); HI-EN—1.25 kg/head/day of dried lucerne chaff and a formaldehyde treated, high-energy supplement (25% tallow, 75% whole soybean) fed *ad libitum;* and B—1.25 kg/head/day dried lucerne chaff and ground barley meal fed to provide the same amount of energy as diet HI-EN.

Sampling and Analytical Methods

During the preliminary and experimental periods, individual milk yields were measured on four days of each week. Two-day composite samples were taken from individual cows twice each week and milkfat and protein contents determined using the Foss "Milko-Tester" and "Pro-milk" recorders. Fatty acid compositions of the HI-EN supplement and treatment group composite milkfat samples were determined using gas-liquid chromatography.

RESULTS

The mean daily intake of HI-EN over the last two weeks of the experimental period was 1.45 kg/head. An equivalent amount of energy was supplied to group B cows by feeding 2.32 kg/head/day of ground barley. However, cows took longer to consume the HI-EN diet which was not as palatable as the barley.

Mean milk yield and composition data for the final two weeks of the experiment are presented in Table 1.

TABLE 1: EFFECTS OF HI-EN AND GROUND BARLEY SUPPLEMENTS ON THE YIELD AND COMPOSITION OF MILK: ADJUSTED MEANS

	Diet			*SE of*	*Signif. of Diff.*	
	Control	*HI-EN*	*Barley*	*Means*	$P<0.01$	$P<0.05$
Milk yield (kg/head/day)	14.7	15.7	15.3	0.4	—	—
Fat (%)	4.13	4.62	4.24	0.06	H>B, H>C	—
Fat yield (g/head/day)	606	715	654	22	H>C	—
Protein (%)	3.31	3.18	3.33	0.04	—	B>H
Protein yield (g/head/day)	495	497	514	18	—	—

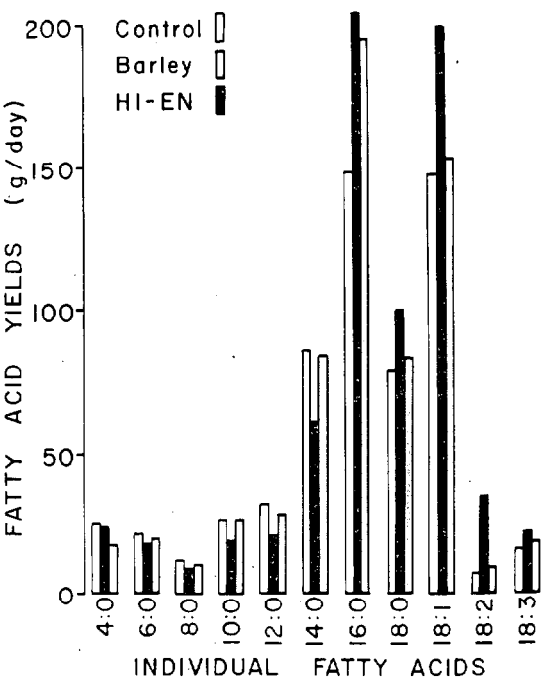

FIG. 1. *Effect of dietary supplements on daily yields of individual fatty acids in milk.*

Supplementation of the diet with HI-EN significantly increased the fat content of the milk compared with that produced by the cows given the barley and control diets. The milk fat yield was also significantly higher for the HI-EN groups than the control groups. However, the protein content of the milk from the HI-EN group was significantly lower than the value for the barley group. Milk and protein yields were not affected by the supplements.

The yields of individual fatty acids in milk fat for the three treatment groups are shown in Fig. 1.

The feeding of HI-EN caused small decreases in the yields of short chain fatty acids (C_4-C_{14}) and quite large increases in the yields of the long chain fatty acids (C_{16}-C_{18}) in milkfat compared with diets B and C. Individual fatty acid yields from cows fed diet B were similar to those from the control group except for increased levels of palmitic acid (C_{16}).

DISCUSSION

Cows fed energy supplements in the form of protected lipid or ground barley failed to show increased milk yields relative to the control animals. This lack of response to concentrate feeding has been noted previously and may be due to substitution of pasture by the supplement (Taparia and Davey, 1970). Measures of pasture intake by the individual treatment groups were not made in this experiment.

Cows fed the protected supplement, however, did produce milk with a higher fat content than those fed the barley supplement and the controls, and yielded more milk fat than the controls. Feeding the HI-EN supplement increased the yield of milkfat by 18% over the controls and the extra fat in the milk (109 g/day) was equivalent to about 17% of the supplemental dietary fat. The fatty acid composition of the milk indicated that this increase in fat yield was brought about by a transfer of about 24% of the long chain fatty acids (C_{16}-C_{18}) of the HI-EN supplement to milkfat, together with a depression in intramammary synthesis of short chain fatty acids. While there was some similarity in the proportions of long chain fatty acids in the HI-EN supplement and those apparently transferred to milkfat (see Table 2) which suggests that the dietary fatty acids were incorporated directly into milkfat, it is also clear that the HI-EN supplement (and the barley supplement—see Fig. 1) favoured the production of palmitic acid.

The observed decrease in the proportion of short chain fatty acids in the milkfat of the cows fed HI-EN may indicate either incomplete protection of the supplement from rumen fermentation

TABLE 2: PROPORTIONS OF LONG CHAIN FATTY ACIDS IN HI-EN SUPPLEMENT, AND APPARENTLY TRANSFERRED TO MILK FAT

	Fatty Acid (% by weight)				
	C_{16}	$C_{18:0}$	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$
HI-EN supplement	22.7	19.1	35.7	17.6	4.9
Fatty acids in "extra" milk fat produced	34.5	12.9	31.9	17.3	3.5

and hence a lower volatile fatty acid production, or a direct effect of long chain fatty acids upon mammary gland synthesis of fatty acids.

The above results agree with those of Storry *et al.* (1974b) who fed protected tallow to cows on a high concentrate diet which depressed milkfat content. Rumen fermentation was unaltered, as indicated by high propionate levels, and synthesis of short chain fatty acids remained depressed. However, fat yields were increased owing to a net transfer of 20% of the tallow fatty acids to milkfat. In the current experiment, the level of barley fed did not result in a depressed fat content in the milk. There was also only a marginal decrease in the C_4-C_{16} fatty acids in the milkfat.

The depression in milk protein content by the HI-EN diet has been noted previously when unprotected oils have been fed to ruminants (Wilson *et al.*, 1966; Storry *et al.*, 1974a) but the mode of action is not known.

It is concluded that the protection of dietary lipids will result in a net trasfer of fatty acids to milkfat and that this more than compensates for any depression in fatty acid synthesis in the mammary gland. Therefore the use of protected tallow supplements on commercial dairy units in New Zealand will clearly depend on the relative costs of the supplement compared with alternative concentrates, and the value of the extra milkfat produced.

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