

# Dairy Nutrition

## Complete Rations for Dairy Cows

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### Story in Brief

There is considerable interest in using complete rations for dairy cows because of the possibilities of reduced labor cost and availability of a typical roughage sources. Materials used in some areas to substitute for hay or silage of conventional rations include citrus pulp, cottonseed hulls, waste paper and sawdust. Since some of these are not universally available and are of limited nutritional value, it was of interest to explore other possibilities for replacing conventional sources of roughage in dairy rations.

Four separate trials were conducted to examine the feasibility of using inert polyethylene (corrugated pellets approximately 10 x 7 x 5 mm in size) as a partial or complete substitute for natural roughage in rations for dairy cows. Measurement criteria were feed intake, rumen fermentation pattern, milk yield and composition, and incidence of digestive disorders. Factors considered in the different trials included the amount of natural roughage (hay) in the ration, procedure for introduction of the polyethylene pellets, and stage in lactation cycle at which the polyethylene was fed.

Under the conditions used in these trials, polyethylene pellets did not substitute effectively for natural roughage in rations for lactating cows. Feed intake was not maintained at a satisfactory level and the rumen fermentation pattern was not commensurate with desired milk fat percentage. There was a progressive decline in the amount of polyethylene retained in the rumen of fistulated animals fed a ration with 10 percent hay so that only 15-19 percent of that fed remained at the end of 4 weeks.

### Introduction

One of the functions of roughage in a dairy ration is to contribute bulk or a "roughness factor" to the rumen ingesta which helps maintain

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the health of the ruminal tissue. This research explored the possibility of using a small amount of inert polyethylene material to serve this function. In particular, it was of interest to consider using material which might stay in the rumen for an extended period, instead of feeding some material on a continuous basis. The criteria by which the effectiveness of inert polyethylene as a roughage substitute was evaluated were as follows:

- a) acceptability of the required amount of polyethylene material by the cows.
- b) feed intake of cows over an extended period.
- c) milk yield and composition.
- d) rumen fermentation pattern.
- e) incidence of digestive disorders.

## Materials and Methods

Trials were conducted to investigate the effects of using polyethylene material under different conditions as regards extent of roughage replacement, procedure for introducing the material, and stage of lactation cycle at which cows were started on experiment.

### Trial 1

Eighteen lactating cows were used in an 8-week trial to evaluate the effects of different amounts of polyethylene<sup>1</sup> and alfalfa hay in the ration. A 3 X 3 factorial arrangement of treatments was used. Levels of polyethylene with time of administration were: a) None, b) 4 lb. fed at start of trial, and c) 4 lb. fed at start of trial plus a daily allotment equal to 1 percent of the grain allowance. Levels of hay as a percent of total ration (air-dry basis) were: a) None, b) 10 percent, and c) 20 percent.

At the start of the trial, 4 lb. of polyethylene material (10 X 7 X 5 mm pellets) were fed to each animal, except those in the zero level group, in equal portions at each feeding over a 4-day period. Essentially all of this amount of polyethylene was consumed. The percentage of hay in the ration was reduced simultaneously by equal increments from 50 percent to the designated level. Grain intake was increased as necessary to maintain constant energy intake.

The grain ration consisted of crimped corn 33.75 percent, crimped sorghum grain 20 percent, wheat bran 15 percent, crimped barley 11 percent, soybean oil meal (44 percent) 10 percent, liquid molasses 7 percent, calcium carbonate 1.25 percent; trace mineral salt 1 percent, calcium phosphate 1 percent.

The animals in the group designated to receive additional polyethylene on a continuous basis were fed an amount equal to 1 percent of the grain ration at each feeding following the initial 4-day period. Although

<sup>1</sup> One-half size corrugated polyethylene pellets (RUFF-TABS) supplied by Farmland Industries, Inc.

the cows varied in their tendency to sort out and refuse the material, it was estimated that three-fourths or more of the daily 1 percent allotment was consumed.

### **Trial 2**

Eighteen lactating cows were used in this trial to evaluate the effects of feeding polyethylene under conditions where all hay was withdrawn from the ration before polyethylene was introduced. The ration treatments were a) Grain + hay (50:50), b) All grain (no polyethylene), and c) All grain + 6 lb. polyethylene. Hay was withdrawn from the ration of cows assigned to the all-grain rations over a 10-day period, with grain increased sufficiently to maintain constant net energy intake. Six pounds of polyethylene were fed to cows in group "c" in equal increments over a 12-day period starting on the second day the cows were on an all grain ration.

### **Trial 3**

All conditions of this trial were essentially the same as those in the previous trial, except that the 12 cows involved were started on the experimental rations prior to calving.

### **Trial 4**

Three fistulated non-lactating animals were used to obtain information regarding the retention of polyethylene in the rumen. The animals were assigned to treatments in a 3 X 3 Latin square design with three 4-week periods and three levels of polyethylene as used in Trial 1. Alfalfa hay was fed at a 10 percent level. During the pre-trial period and each 2-week interval between periods, a 50:50 hay to grain ration was fed. Introduction of the polyethylene was accomplished in the manner described in Trial 1, except that material refused during the initial 4-day period was separated from the grain and introduced through the rumen fistula.

At weekly intervals rumen ingesta samples were collected, and at the end of each 4-week period the rumen-reticulum was completely emptied to determine the retention pattern of the polyethylene in the rumen.

## **Results and Discussion**

### **Trial 1**

In general, feed intake by the different groups was a reflection of feed allowances, based on net energy requirements for maintenance and production. A general decline in intake during the first 4 weeks of the trial was attributed to numerous incidents of temporary off-feed conditions where individual cows refused a large percentage of their feed.

There was very little difference in the number of incidents of feed refusals among groups fed different levels of hay; however, larger amounts of feed were refused by the group fed no hay. Feeding of the polyethylene in the manner indicated in the previous section tended to reduce the incidence of feed refusals in this trial, at least to some extent. However, feed intake was not maintained in any of the groups at a satisfactory level for high milk production.

Neither level of hay nor level of polyethylene had a significant effect on milk yield, and there was not a significant interaction between the two factors. Average production by the group fed no hay declined more in relation to pre-trial production than that of the other groups (Table 1), presumably because of a greater decrease in feed intake as noted above.

The cows receiving no hay exhibited a substantial decrease in milk fat percentage, whereas a smaller decline was evident in the groups fed either 10 or 20 percent hay. Average fat percentages for different polyethylene groups was 3.3, 3.4 and 3.1 for the zero, 4 lb. initial, and 4 lb. plus 1 percent daily groups, respectively. Thus, feeding of polyethylene under the conditions of this trial was not an effective means of maintaining desirable fat percentage in milk of cows fed high grain rations.

Table 1. Average Daily Milk Yield and Composition

Treatment group	Pre-trial		1-4 weeks			5-8 weeks		
	Milk	Fat	Milk	Fat	T.S.	Milk	Fat	T.S.
	(kg)	(%)	(kg)	(%)	(%)	(kg)	(%)	(%)
No hay								
No polyethylene	23.1	3.4	20.5	3.0	11.65	17.1	3.1	11.79
1.8 kg	22.6	3.6	19.2	3.1	11.81	16.4	2.9	11.48
1.8 kg + 1% daily	26.2	3.2	23.1	2.7	11.75	21.1	2.9	11.85
Average	24.0	3.40	20.9	2.91	11.74	18.2	2.97	11.72
10% hay								
No polyethylene	23.4	3.6	21.7	3.3	12.30	20.6	3.6	12.52
1.8 kg	23.5	4.2	22.3	3.7	12.74	18.8	3.5	12.32
1.8 kg + 1% daily	20.4	3.4	19.6	3.5	12.50	17.8	3.2	12.08
Average	22.4	3.73	21.1	3.47	12.51	19.1	3.43	12.31
20% hay								
No polyethylene	21.8	3.7	21.1	3.7	12.49	18.1	3.8	12.83
1.8 kg	23.2	3.5	20.6	3.5	12.57	19.1	3.3	12.40
1.8 kg + 1% daily	21.1	3.7	19.4	3.0	11.50	17.3	3.0	11.35
Average	22.0	3.63	20.4	3.40	12.19	18.2	3.33	12.19

Molar percentages of ruminal volatile fatty acids (VFA) during the pre-trial period were typical of values expected for cows consuming rations with a 50:50 ratio of grain to hay. Removal of all or part of the hay resulted in a lower percentage of acetic acid and a correspondingly higher percentage of propionic acid in the rumen fluid, as illustrated by acetic/propionic ratios during the second week of the experiment (Figure 1). The feeding of polyethylene had no consistent effect on the proportion of VFA in the rumen. Thus, the polyethylene material did not substitute effectively for roughage in terms of maintaining a typical fermentation pattern in the rumen.

## Trial 2

Average production of the group of cows fed 6 lb. each of polyethylene at the start of an 8-week comparison period was lower than that of either of the control groups (Table 2). During the week that polyethylene was introduced, feed intake by the cows fed the polyethylene dropped below that of the other group fed only grain. Complete recovery in grain

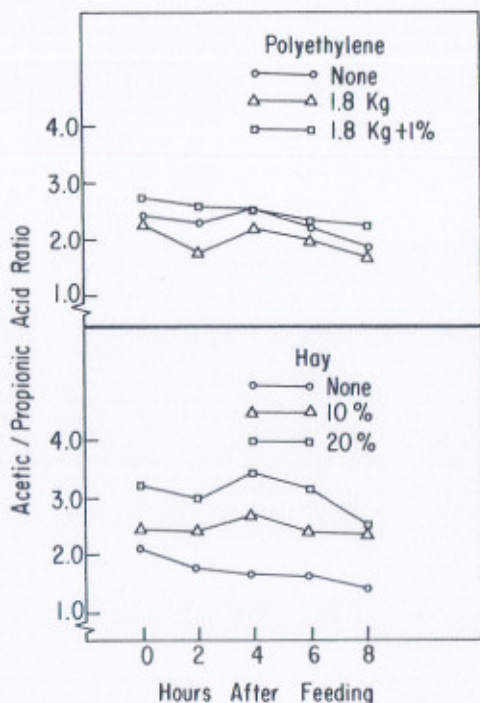


Figure 1. Acetic to propionic acid ratios in rumen fluid of cows during the second week of the experiment.

**Table 2. Average Feed Intake and Milk Production of Cows—Trial 2.**

Item	Ration treatment		
	Grain & hay (50:50)	Grain only	Grain + polyethylene
Air-dry feed intake, kg, day	19.3	14.4	11.4
Milk yield, kg/day	19.1	19.4	14.3
Fat, %	4.1	3.4	3.5
Total solids, %	13.0	12.4	12.3

intake did not occur, which may account for the lower production by this group.

The percentages of milk fat and total solids was lower in both groups fed all grain than in the control group fed both hay and grain (Table 2). Very little difference was evident until the third week on the experimental rations. From this point through the end of the trial, milk from the all-grain groups tested approximately 0.8 percent lower than that from the control group.

The amount of time spent ruminating was reduced markedly in both groups of cows fed an all-grain ration (Table 3). The polyethylene material did not promote increased rumination; however, a few cows were observed to regurgitate and discard the material. As in the previous trial, the observed pattern of rumen VFA production was not commensurate with maintenance of desired milk fat test.

### Trial 3

In this trial cows were started on the experimental rations before calving. The results were similar to the previous trial, except that differences in fat test were less consistent (Table 4). Presumably, body stores were used for milk fat synthesis during the 12 weeks following calving with the result that distinct differences in fat test due to different rations did not become apparent. Nevertheless, it may be concluded that intro-

**Table 3. Observations on Rumination During a Six-hour Period Two Weeks After Initiation of Trial 2.**

Group	Hour after feeding						Total for 6 hr.
	2nd	3rd	4th	5th	6th	7th	
	Time spent ruminating (minutes)						
Hay + grain	0	10	17	17	21	20	85
Grain only	0	0	0	1/3	2/3	6	7
Grain + plastic	0	0	0	0	0	3	3

duction of the polyethylene material prior to calving did not alleviate all of the problems associated with feeding dairy cows an all-grain ration.

#### Trial 4

Under the conditions of this trial where the ration contained 10 percent roughage, there was a progressive decline in the amount of polyethylene retained in the rumen (Table 5). The material did not accumulate in the rumen of any of the three animals fed a 1 percent level daily. In fact, the polyethylene remaining in the rumen at the end of 4 weeks averaged 19 percent of the amount fed in animals given 4 lb. only at the start of the trial, as compared to 15 percent for those fed the same amount initially plus 1 percent daily.

Table 4. Average Feed Intake and Milk Production of Cows—Trial 3.

Item	Ration treatment		
	Grain + hay	Grain only	Grain + polyethylene
Air-dry feed intake, kg/day	18.9	11.5	9.9
Milk yield, kg/day	22.4	18.4	18.5
Fat, %	3.9	4.0	3.7
Total solids, %	13.01	12.75	12.01

Table 5. Retention of Polyethylene in Rumen of Fistulated Animals

Polyethylene treatment	Polyethylene in rumen at end of week:			Ingesta removed at end of 4-week period		
	2	3	4	Total DM (kg)	Polyethylene (g)	Polyethylene (% of DM)
1.8 kg initially	— (% of DM) —			5.9	345	4.8
1.8 kg initially + 1%/day	19.6 <sup>1</sup>	12.1	5.1	4.0	281	8.4

<sup>1</sup> Each value is the average of three animals.