Published by:
Teagasc
19 Sandymount Avenue,
Dublin 4.

On-farm Factors Influencing the Chemical Quality of Milk for Processing

Final Report

Project Number 3879

Dairy Levy Series No 1

On-farm Factors Influencing the Chemical Quality of Milk for Processing

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Teagasc acknowledge with gratitude the support of Dairy Levy Farmer Funds and European Union Structural Funds (FEOGA and ERDF) in the financing of this research project.

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ISBN 1 901138 01 1

September, 1996

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Agriculture and Food Development Authority

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SUMMARY

The objective of this project was to provide new information, on the relationship between the plane of nutrition of the cow and the chemical composition of the milk, its processing characteristics and the quality of products manufactured from this milk. The project concentrated on the investigation/development of both feeding and milking strategies which would result in the production of quality processable milk over the year.

- Milk yield, protein and lactose concentrations and free fatty acid (FFA) levels were not affected by milking with a 12:12 hour interval compared to a 16:8 hour interval. Fat concentration was reduced with the 12:12 hour interval.

- Both milk yield and FFA levels were reduced by once a day milking at the end of lactation. If once a day milking was commenced at 8-10 kg per day, cows should be dried off at 7.0-7.5 kg per day to maintain a low FFA level in the milk.

- There was no significant difference in FFA level of milk when mid-level and low-level milking systems were used. Intermittent pumping of milk, a low claw air admission and float valves in recorder jars all reduced FFA levels in milk. Vacuum fluctuations exceeding 2 kPa in the milking system did not affect FFA level of milk.

- Replacing up to 50% grass silage with early-spring grass, combined with concentrate supplement of 4 kg per cow per day, reduced FFA levels in milk of cows in early lactation. When combined with 6 kg concentrate per cow per day, renneting properties of milk were improved.

- Supplemention of early lactation cows on grazed grass with 2 kg and 4 kg concentrate per day reduced FFA levels in milk. Processability measurements such as renneting properties and casein number were not affected by supplementation.

- Increasing cow intake, either by lowering stocking rate and including concentrates in the diet or by increasing daily herbage allowance to cows, increased milk yield, total protein, true protein and casein concentrations.

- Processability parameters deteriorated at the high stocking rate (4.0 cows/ha) compared to the standard system (3.57 cows/ha).

- Supplementation of the standard diet either with concentrates or by increasing daily herbage allowance above 20 kg DM/cow did not improve processability parameters compared to the standard system.

- A superior cheddar cheese was manufactured from the supplemented herd milk (compared to the restricted herd milk (4.0 cows/ha) in terms of higher yield, lower fat, higher protein and lower moisture.

- Daily herbage allowance of the cow did not affect the functionality of Mozzarella cheese but did affect its yield.

- A superior whole milk powder was manufactured from the supplemented herd milk (compared to the restricted herd milk) in terms of WPN1, TBA and PV values. Thus, the application of the standard, recommended system of milk production would not adversely affect either the processability of milk or cheese quality in mid-lactation. However, protein content of milk and yield of cheese could be increased with increased cow intake.

- Where adequate quantities of good quality grass are available in the autumn (mid-September onwards), high milk production can be obtained. In this situation, little response was obtained in terms of milk production in using silage as a buffer feed. Concentrate supplementation increased milk yield and yield of milk constituents. Supplementation with either silage or concentrates reduced FFA levels considerably (particularly at 4 kg/cow/day). Processability parameters such as renneting properties were not affected by supplementation in the presence of adequate grass supply.

On-farm Factors influencing the Chemical Quality of Milk for Processing

Raw material of a consistent composition is a necessary requirement for any processor who wishes to compete in the market with fresh products, functional products or indeed most dairy products.

In Ireland, milk for processing is produced on a seasonal basis. While this milk supply system takes maximum advantage of grass as a feed, the seasonality of supply presents particular problems for processing and marketing. Seasonal changes in milk composition reflect lactational and nutritional influences. Apart from changes in the principal milk components of fat, protein and lactose, other changes in milk quality which affect processability and product quality can arise. While these changes are more pronounced in late lactation, they can occur at any time throughout the lactation and have wide-ranging effects on dairy products.

The major factors which affect the production of quality milk at farm level include cow nutrition throughout the lactation and milking management. In practice the level of nutrition on farms can be variable. In the early Spring period poor grass growth rates and difficult grazing conditions can affect cow nutritional level. Incorrect grazing management or drought conditions can affect cow nutrition during the mid-lactation period. Generally, late-lactation milk is regarded as being of poorer quality for processing than mid-lactation milk and there is some evidence that undernutrition of the cow at this stage can disimprove the processing characteristics of the milk further.

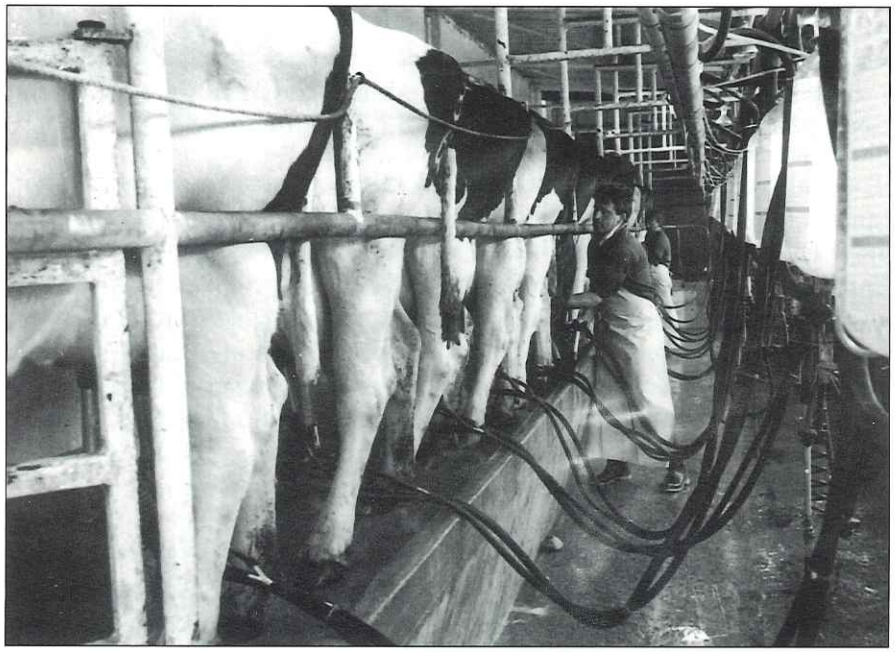
Due to compositional and functionality defects of late-lactation milk, it is necessary to preclude it from product manufacture before the late-lactation 'effects' adversely affect product quality. Thus, an effective drying-off strategy is necessary. The milking procedure and equipment may also influence milk quality. Many studies have reported the importance of various milking machine design features particularly in relation to free fatty acid levels and subsequent off-flavour in milk and milk products.

The objective of this project was to provide new information on the effect of cow nutrition and milking management on the chemical composition of milk, its processing characteristics and the quality of products manufactured from this milk.

Effect of milking interval on milk yield, and FFA level in milk

This study was undertaken to investigate the effect of an unequal and equal milking interval on milk yield, milk composition and FFA level of milk from high producing cows at peak lactation.

A total of 66 cows were assigned to two treatments: (1) a 16:8 hour between milking interval, and (2) a 12:12 hour between milking interval. The experimental treatments were applied for 4 weeks (April 16 - May 14). The average yearly milk yield of the cows was 5,037 kg. The average pre-experimental week milk yield was 23 kg/cow/day.



Milk production, composition and free fatty acid level were not adversely affected by milking interval

A 12:12 hour between milking interval significantly reduced milk yield, the yield of milk fat, protein and lactose at morning milkings. Fat concentration was significantly increased at morning milking by a 12:12 hour interval. The yields of milk, protein and lactose were significantly

increased at evening milking with a 12:12 hour interval. Fat concentration was reduced at evening milking with a 12:12 hour interval.

There was no difference between the 16:8 hour and 12:12 hour interval in respect of daily yields of milk, protein and lactose. Daily milk fat yield and concentration were significantly reduced by the 12:12 hour interval. Daily protein and lactose concentrations were not affected by milking interval. FFA of daily milk was reduced ($P<0.05$) in week 2 and increased ($P<0.05$) in week 3 with the 12:12 hour interval. An effect was not seen in weeks 1 and 4.

In conclusion, milk production, composition and FFA level of milk was not adversely affected by a 16:8 hour compared to a 12:12 hour interval, at present levels of milk yield, in early lactation and using present production methods. However, it may not be possible to extend this to cows yielding in excess of 6360 litres (1400 gallons). At present, there is no clear-cut evidence of an adverse effect on milk production specific to high producing cows caused by unequal milking intervals, but indications for such an effect have been noted.

Effect of milking interval on daily milk yield and milk composition

Milking Interval	16 : 8h	12 : 12h	Significance
Milk yield (kg/cow/day)	25.1	25.0	-
Fat yield (kg/cow/day)	0.867	0.825	*
Protein yield (kg/cow/day)	0.823	0.820	-
Fat %	3.47	3.30	*
Protein %	3.29	3.28	-
Lactose %	4.52	4.56	-

The effect of drying-off techniques at end of lactation on milk production and quality

The experiment was undertaken with a number of objectives in mind:

(i) To determine the effect of once a day milking versus twice a day milking in terms of milk yield, milk composition and free fatty acid level,

(ii) To establish the yield at which cows should be changed to once a day milking if this is advantageous (determined from (i) above), and

(iii) To establish the milk yields at which cows should be dried off with both once a day and twice a day milking.

Two groups of 12 cows each were milked once a day and twice a day, respectively, for 7 weeks (1/11/93 - 19/12/93). All cows were fed 0.9 kg concentrate per day. Two further groups of 26 cows each were changed from twice a day milking to once a day milking at 13-15 kg/day and at 8-10 kg/day, respectively, during a period of 13 weeks (20/9/93 - 19/12/93). Cows were reduced from 2 kg concentrate/day to 1 kg/day when once a day milking was commenced. All cows were dried off when a yield of 3.5 - 4.0 kg/day was reached.

Milk yield was significantly reduced by once a day milking for each week of the experiment. Fat yield and protein yield were not affected by once a day milking but lactose yield was also significantly reduced on a weekly basis by once a day milking. Once a day milking significantly reduced FFA on each week of the experiment.

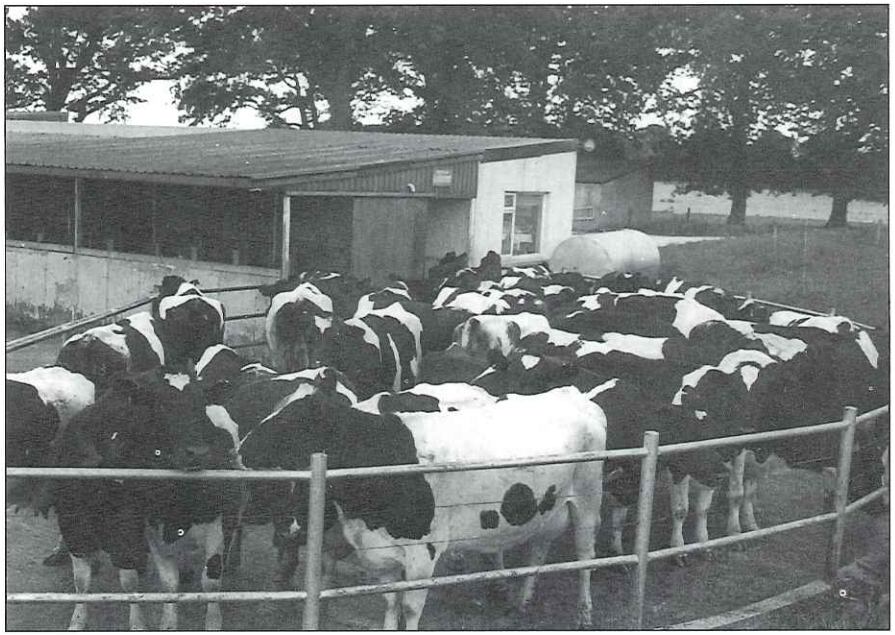
Commencing once a day milking at a milk yield of 13-15 kg/day compared to 8-10kg/day did not affect milk yield, fat yield, protein yield or lactose yield. FFA level of herd milk was not affected by commencing once a day milking at 13-15kg/day compared to 8-10kg/day.

The results indicate that to maintain FFA levels below the target level of 0.6 mmole/100g fat, cows should be milked once a day and dried off at a milk yield of 7.0-7.5kg/day if once a day milking is commenced at 8-10kg/day; if once a day milking is commenced at 13-15kg/day, then

cows should be dried off at a milk yield of 6.0-6.5kg/day. If twice a day milking is continued cows must be dried off at a milk yield greater than 9kg/day.

The influence of milking machine factors on FFA level of milk

The milking machine is generally the single most important cause of high FFA levels in milk. The admission of air is required to lift and transport milk through the milking system and this presents a major risk to milk fat damage. A number of factors associated with the component make-up, design and operation of milking machines were tested in relation to their influence on FFA level.



Fat yield and protein were not affected by once a day milking

Continuous pumping of milk significantly increased free fatty acid levels of p.m. milk but did not affect a.m. milk. This was due to the small volume of milk at evening milking. A claw air admission of 13 litres per minute significantly increased FFA level of the a.m. milk but did not affect p.m. or total daily milk. The absence of float valves significantly increased

FFA level of a.m. milk, p.m. milk and total milk. There was no difference in FFA levels of milk between 2 x 2 and 4 x 0 pulsation with the bucket milking system or the direct-to-line milking system.

A direct-to-line system (milk transferred to a 63 mm milkline which entered a horizontal receiver jar) resulted in significantly higher FFA levels than the bucket system at a.m. milking, at p.m. milking and for total daily milk. The mid-level recorder system (including low claw air admission, 38 mm transfer line, float valves and intermittent pumping) resulted in significantly higher FFA levels at p.m. milking but did not affect a.m. or daily milk. The FFA levels were 0.688, 0.756 and 0.590 mmoles/100 g fat for the recorder, direct-to-line and bucket systems, respectively.

These results indicate that the optimal treatment (in relation to FFA level of milk) involves intermittent pumping, a claw air admission of 6 litres per minute and float valves in the recorder jar, the presence of float valves being the most critical component. Simultaneous or alternate pulsation is not critical. A well designed and maintained mid-level system does not significantly increase daily milk FFA levels compared to a bucket system.

The effect of replacing grass silage with early Spring grass on milk quality

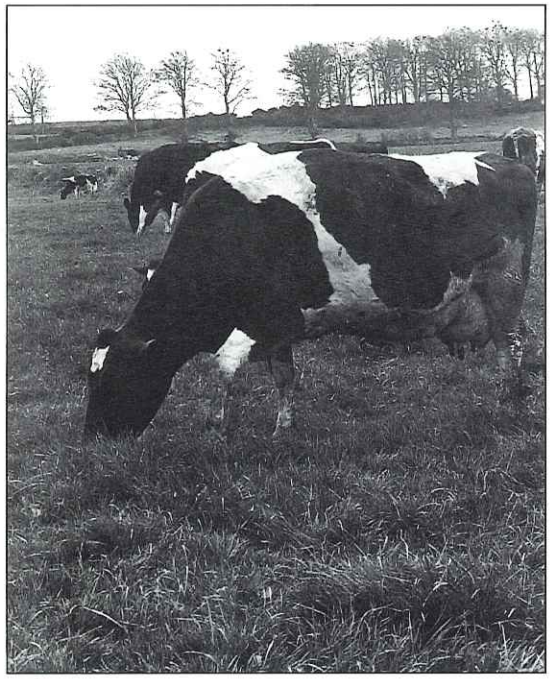
The objective of this experiment was to quantify the effect on FFA level and processability of milk, in early lactation, from increasing cow intake by: (i) replacing up to 50% of the silage component of the diet with grazed grass and (ii) concentrate supplementation.

Treatments were as follows :

T1 : Grass silage + 6 kg conc.;
T2 : Grass silage + grazed grass + 6 kg conc.;
T3 : Grass silage + grazed grass + 4 kg conc., and
T4 : Grass silage + grazed grass + 2 kg conc.

The experiment was carried out over an 8 week period (February 27 - April 24, 1993).

The combination of silage + grass + 4 kg concentrate resulted in significantly lower BDI (Bureau of Dairy Index) levels than T1, T2 and T4. The processability measurements (which indicate the suitability of milk for cheesemaking) - rennet coagulation time (RCT), rate of curd aggregation (K20) and curd firmness (A30) were all significantly improved with T2 (silage + grass + 6 kg conc.) compared to T1, T3 and T4. Casein number was not affected by the treatments.



Meal supplemtation at grass in early lactation reduced free fatty acid levels

The effect on milk processability of feeding concentrate to grazing cows

Grass growth rates and grazing conditions can be erratic in the April/May period, depending on climatic conditions. This period also coincides with high stocking rates (allowing for 1st-cut silage conservation) and with the breeding season. Therefore, in periods of poor grass supply and difficult grazing conditions in early Spring, FFA levels could increase due to low cow intake levels. Concentrate supplementation may counteract this. Milk renneting characteristics could also improve as a consequence of potentially higher protein levels.

A total of 33 cows were on experiment for 9 weeks (April 10 - June 12). Treatments were as follows :
T1 : Grass + 4 kg conc.; T2 : Grass + 2 kg conc.; and T3 : Grass alone.

Supplementation with concentrate significantly reduced FFA levels in weeks 1-4, weeks 5-9 and weeks 1-9. The effect was linear. The rennet-ing characteristics (RCT, K20 and A30) were similar for all treatments. The casein number of the milks from all treatments were similar with that of the unsupplemented group being generally slightly higher.

Effect of supplementating Spring grass with concentrates on FFA level of milk (mmoles/100 g fat)

Week	Grass only	Grass + 2 kg conc.	Grass + 4 kg conc.	s.e.	Significance
1-4	0.616	0.494	0.456	0.0520	*
5-9	0.670	0.451	0.472	0.0334	***
1-9	0.644	0.478	0.456	0.0466	**

s.e. = standard error

The effect of cow nutritional level on:

1 Milk composition and processability

The production requirements for quality milk will have to be defined to facilitate the manufacture of a range of quality dairy products. Previous research has indicated that the nutritional status of the cow is a major influence on milk production, composition, and milk processing quality. The present study was undertaken to compare the effect of three different nutritional levels on milk yield, milk composition and a range of milk quality parameters which would indicate the suitability of the milk for processing.

Forty-eight cows were assigned to three treatments for a 28 week period (April 18 - October 30). The treatments were as follows:

T1 : Restricted grass supply;
T2 : Standard grass management system, and
T3 : Standard grass management system + concentrate.

Treatment 1 and Treatment 2 cows were stocked at 6.18 cows/ha and 5.49 cows/ha, respectively during the period April 18 - June 12, at 4.62 cows/ha and 4.12 cows/ha during the period June 13 - July 30, and at 3.36 cows/ha and 3.00 cows/ha during the period July 31 - September 4, and at 3.08 cows/ha and 2.75 cows/ha during the period September 5 - October 30. Treatment 1 cows received no concentrates. Treatment 2 cows, received 62 kg concentrate/cow, and Treatment 3 cows, which were stocked at the same rate as Treatment 2 cows, received 650 kg concentrate/cow during the experimental period. Treatment groups were grazed separately with a residence time of 3 days/plot.

Continuous pumping of milk increased free fatty acid levels in p.m. milk but did not affect a.m. milk

Milk yields were measured on individual cows 3 days each week, while milk fat, protein and lactose were measured on one a.m. and p.m. sample weekly. Bulk milk from the 3 herds was collected separately at one a.m. and p.m. milking per week for more detailed analysis. Rennet coagulation properties were measured using a formagraph. The N fractions of milk were measured by Kjeldahl.

Milk yield was significantly higher on Treatment 3 compared to Treatments 1 and 2 which were not different. Protein concentration was significantly lower on Treatment 1 compared to Treatments 2 and 3 which were not different. Fat yield was higher on Treatments 2 and 3 compared to Treatment 1 and protein yield increased significantly from Treatment 1 to 2 and from Treatment 2 to 3. Differences between rennet coagulation times (RCT) of the different milks were small.

Milk from Treatment 1 had poorer rate of curd aggregation (K20) and curd firmness (A60) than milks from Treatments 2 or 3. This trend was consistent even after pH adjustment of milks to one value. Total protein, true protein and casein protein levels were consistently lower in Treatment 1 compared to Treatment 2 and consistently higher in Treatment 3 compared to Treatment 2. While casein number was not generally affected by treatments, the casein to true protein ratio was higher in Treatment 1 than in Treatment 2 and 3 milks.

Restricting grass supply resulted in reduced milk fat and protein yields, a lower protein concentration and poor rennet coagulation properties. Feeding concentrate supplement with an adequate grass supply increased milk and protein yield, and gave small improvements in the milk characteristics associated with better processability into cheese.

Effect of nutritional level on milk yield and composition

Treatment	Restricted grass (T 1)	Standard grass (T 2)	Std. grass + conc. (T 3)	Standard error
Milk yield (kg/cow/day)	16.9	18.0	19.3	0.382
Fat concentration (g/kg)	41.17	41.17	40.36	0.712
Protein concentration (g/kg)	33.64	34.69	35.06	0.281

II Whole milk powder manufacture

Bulk milk from 2 herds (restricted and supplemented) was collected separately at one a.m. and p.m. milking when milk powder was to be manufactured. Milk powder was manufactured on 12 occasions over the experimental period.

Results of this experiment generally indicate a superior product can be manufactured from the supplemented herd milk. A measure of undenatured whey protein nitrogen determines the heat classification of the powder. A powder may be classified as 'low heat' if the undenatured whey protein nitrogen level ≥6.0 mg/g powder. In this trial, powder manufactured from the restricted herd milk was borderline on this classification, whereas powder from the supplemented herd milk fell well within the outlined standard.

Peroxide values (PV) are a measure of lipid oxidation and thiobarbituric acid values (TBA) indicate the level of secondary breakdown products. Powder from the restricted herd milk had slightly higher PV and TBA values compared with powder from the supplemented herd milk.

III Cheddar cheese manufacture

Bulk milk from 2 herds (restricted and supplemented) was collected separately at one a.m. and p.m. milking when cheese was to be manufactured. Cheddar cheese was manufactured on 5 occasions over the experimental period.

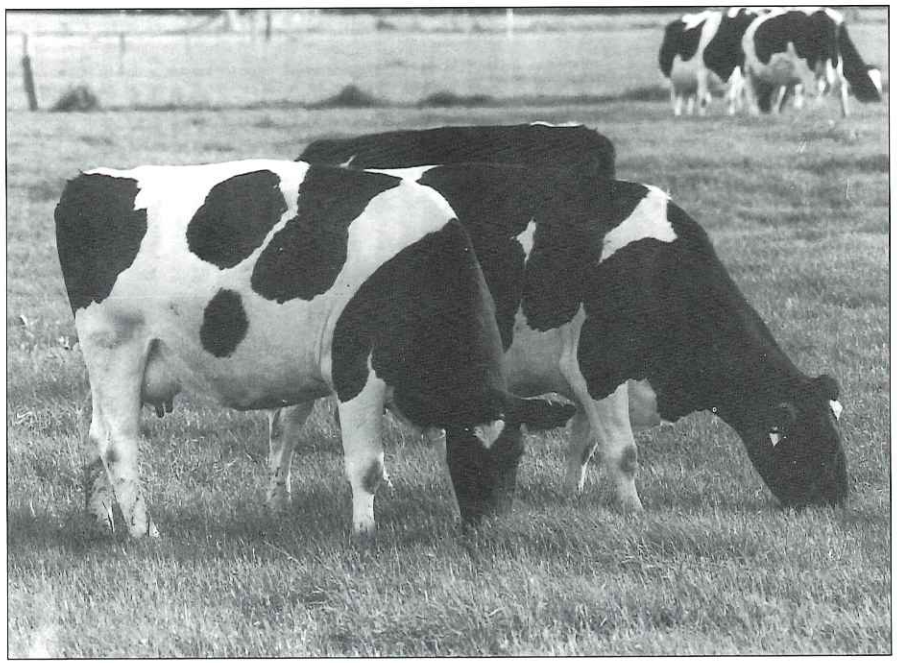
Analysis of the data indicated significantly higher protein in the whey and a higher FDM in the cheese manufactured from milk of the supplemented herd. Cheese yield was also significantly higher with supplemented herd milk. Higher fat, reduced protein and higher moisture levels were also observed in the cheese made from the restricted compared to the supplemented diet.

Both cheddar cheese and whole milk powder manufacture was carried out as a joint study with The National Dairy Products Research Centre, Moorepark.

The effect of daily herbage allowance on:

I The chemical composition and processability of milk

During the mid-lactation period, dairy product manufacturers can experience difficulty in producing high quality dairy products. These problems are thought to be related to changes in milk characteristics such as protein concentration, protein composition and rennet coagulation properties of milk. These milk characteristics may in turn be influenced by level of feeding and diet quality. Thus, when different grazing strategies are being evaluated, these characteristics of milk are an essential consideration in the



Increasing herbage allowance increased milk yield, total protein and casein concentration but did not affect milk processability

assessment of the grazing regime. This study was undertaken to establish the effect of offering three different daily herbage allowances to cows on milk protein concentration, protein composition and rennet coagulation properties of milk.

Thirty-six cows were assigned to three treatments for a 17 week period (May 2 - August 27). Treatments 1, 2, and 3 were offered daily herbage allowances of 16, 20 and 24 kg DM/cow, respectively. Each treatment grazed its own experimental area separately. Grazing areas were allocated daily on the basis of pre-grazing herbage mass. Feed composition was similar across the treatments. Milk samples were taken from all cows once every 4 weeks, at one a.m. and one p.m. milking, composited by cow, and analysed for protein fractions, rennet coagulation properties, alcohol stability and free fatty acid (FFA) level. Milk yield and gross composition of milks from these 12 cows was measured on 5 days and 2 days per week, respectively. Rennet coagulation properties were measured using a formagraph. The protein fractions of milk were measured by the Kjeldahl method.

Effect of daily herbage allowance on the chemical composition and processability of milk

Daily Herbage Allowance	16kg DM/cow (T1)	20kg DM/cow (T2)	24kg DM/cow (T3)	S.E.D.	Significance
Milk yield (kg/cow/day)	19.3	21.2	22.0	0.64	**
Fat concentration (g/kg)	38.2	39.0	37.9	0.80	NS
Total protein (g/kg)	32.0	33.2	34.1	0.84	*
True protein (g/kg)	30.0	31.1	32.1	0.86	*
Casein (g/kg)	24.3	25.5	26.1	0.69	*
Casein number	75.9	76.8	76.6	0.60	NS
Whey protein (g/kg)	5.7	5.7	5.9	0.29	NS
RCT (min)	19.0	19.7	19.1	1.27	NS
A60 (mm)	40.7	43.3	44.1	2.27	NS
Alcohol stability (%)	75	76	77	2.8	NS
FFA (mmol/100g fat)	0.634	0.535	0.555	0.0678	NS

There was a significant linear increase in milk yield, total protein concentration, true protein concentration and casein concentration with increasing herbage allowance. Casein number and whey protein level were not affected by the treatments. Rennet coagulation time (RCT) and curd firmness (A60) at the natural pH of milk and pH adjusted to 6.6 were not affected by the treatments. Alcohol stability and FFA level of milk were also not affected by the treatments.

Increasing herbage allowance increased milk yield, total protein, true protein and casein concentrations but did not affect milk processability, in terms of rennet coagulation time, curd firmness, alcohol stability and free fatty acid level.

The results generated indicate that daily grass allowance has a major influence on milk yield and chemical composition. It does not affect the processability parameters measured. This knowledge leads to a better understanding of the effect of cow diet on the detailed chemical and processing characteristics of milk. It helps to define the daily grass allowance required by the cow to produce milk suitable for processing in mid-lactation.

(II) Mozzarella cheese manufacture

Bulk milk from the 3 herds was collected separately at two a.m. and two p.m. milkings when Mozzarella cheese was to be manufactured on 5 occasions over the experimental period.

Protein concentration of milk for cheesemaking was significantly increased with increasing daily herbage allowance. Milk fat and lactose concentrations were not affected by the treatments. Increased daily herbage allowance significantly increased cheese yield, moisture adjusted cheese yield, moisture adjusted cheese yield per 100 kg of protein adjusted milk and moisture adjusted cheese yield per 100 kg of casein and fat adjusted milk. All cheeses were within specification and did not differ in terms of composition, ripening behaviour, meltability, flowability, stretchability and viscosity.

Increased daily herbage allowance increased the yield of cheese but did not affect cheese functionality properties. Thus, the daily herbage allowance of the cow in mid-lactation does not affect the functionality of Mozzarella cheese but it does affect its yield.

(III) Whole milk powder manufacture

Bulk milk from the 3 herds was collected separately at three a.m. and p.m. milkings when milk powder was to be manufactured. Whole milk powder was manufactured on 6 occasions over the experimental period. Data analysis on results obtained are not completed to-date.

Both Mozzarella cheese and whole milk powder manufacture was carried out as a joint study with DPC.

The effect of offering a concentrate or silage supplement to grazing dairy cows in late lactation

The Autumn period on dairy farms coincides with large changes in the type and quantity of forage available to the dairy cow. Grass growth rates decline rapidly at this time of year. The issue arises as to when silage feeding should commence, and if it would be economical to introduce concentrate feeding.

The present study was undertaken to compare the effects of two levels of silage and two levels of concentrate, offered as supplements to pasture, towards the end of the grazing season on production and processability characteristics of milk. Seventy cows were assigned to the following five treatments :

T1 : Grass only,
T2 : Grass + 2 kg silage dry matter (DM)/day,
T3 : Grass + 4 kg silage DM/day,
T4 : Grass + 2 kg concentrate DM/day, and
T5 : Grass + 4 kg concentrate DM/day.

The treatments were applied for 10 weeks (September 14 - November 24). The cows were stocked at 2.69/ha and grazed as one group. Grass was grazed to a post-grazing sward surface height of 6 to 7 cm.

Supplementation with grass silage had no effect on milk yield or yield of milk constituents but it significantly reduced protein and lactose concentrations. Concentrate supplementation significantly increased milk, fat, protein and lactose yields and lactose concentration but it reduced fat concentration. Both levels of concentrate and the high level of silage supplementation maintained FFA levels at or below the target level of 0.6 mmoles/100 g fat up to week 6 and week 8, respectively.

The milk casein numbers were similar for all treatments although that of the high silage group was consistently lower. The rennet coagulation time, rate of curd aggregation and curd firmness were similar for all treatments.

In conclusion, where adequate quantities of high quality grass are available high milk production can be obtained. In this situation little response will be obtained, in terms of milk production, in using silage as a buffer feed. It will generally be economic to feed 2 kg of concentrate in the Autumn (to Spring-calving cows), based on the present milk : concentrate price ratio.

Effects of grass supplementation with silage or concentrates on milk yield, milk composition and on liveweight gain

	Treatments						Significance		
	Grass only (T1)	Grass + 2kg silage (T2)	Grass + 4kg silage (T3)	Grass + 2kg conc (T4)	Grass + 4kg conc (T5)	s.e.	Grass Vs silage	Grass Vs conc	Silage Vs conc
Milk yield (kg/cow/day)	11.2	11.2	10.5	13.0	13.8	0.31		***	***
Fat yield (kg/cow/day)	0.47	0.46	0.43	0.53	0.54	0.013		***	***
Protein yield (kg/cow/day)	0.42	0.41	0.39	0.48	0.53	0.011		***	***
Lactose yield (kg/cow/day)	0.50	0.49	0.46	0.58	0.63	0.015		***	***
Fat concentration (g/kg milk)	42.85	41.10	40.52	40.72	38.98	0.088		**	
Protein concentration (g/kg milk)	37.58	36.79	36.76	37.37	38.05	0.028	*		**
Lactose concentration (g/kg milk)	44.22	43.74	43.37	44.67	45.23	0.107	**	***	***
Average daily gain (g/day)	76	2	302	384	412	0.067	*	**	**

CONCLUSIONS

- Milk yield, protein and lactose concentrations and FFA levels were not affected by milking with a 12 : 12 hour interval compared to a 16 : 8 hour interval.
- If once a day milking was commenced at 8 - 10 kg/day, cows should be dried off at 7.0 - 7.5 kg/day to maintain a low FFA level in milk.
- Selection of correct milking machine components, correct installation and regular maintenance of the machine reduces milk FFA levels.
- Replacing up to 50% grass silage, in the diet, with early Spring grass combined with concentrate supplementation of 4 kg/cow/day, reduced FFA levels in milk in early lactation.
- Supplementation of early lactation cows on grazed grass with 2 kg and 4 kg concentrate per day also reduced FFA levels.
- Supplementation of late lactation Spring-calved cows on grazed grass with silage gave no response in terms of milk production. Concentrate supplementation increased milk yield and yield of milk constituents. Supplementation with either silage or concentrates reduced FFA levels considerably (particularly at 4 kg/cow/day).
- It is difficult to improve both renneting properties and casein number of milks by supplementation in early and late lactation.
- The application of the standard, recommended system of milk production would not adversely affect either the processability of milk or cheese quality in mid-lactation. However, this system has to be strictly managed and controlled.
- Protein content of milk and yield of cheese could be increased with increased cow intake in mid-lactation.

PUBLICATIONS

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