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## The Nutritive Value of Colostrum for the Calf

### 5. The Effect of Prepartum Milking

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The milking of cows and heifers before parturition has been advocated as a means of reducing the congestion of the udder and the associated oedema at calving, and of increasing the milk yield of the cow during the subsequent lactation period. The extent of pre-milking varies widely; on some farms, cows are milked only once or twice before parturition, whereas on others they are milked twice daily for up to 30 days.

The composition of the secretion produced at calving is altered by prepartum milking (Eaton, Johnson, Spielman, Matterson & Nezvesky, 1949*a*), there being a reduction in the total nitrogen and in the percentage of non-casein nitrogen; the extent of this decline depends on the quantity of secretion removed before calving (VanLandingham, Weakley, Ackerman & Hyatt, 1949). It is possible that the postpartum secretion of pre-milked cows may be of less benefit to newborn calves than normal colostrum, and it

was observed in America that calves from dams that had been milked parturum were more difficult to rear (Turner 1931, Davis & Trimberger, 1941). Furthermore, calves given for 1 week fixed amounts of the milk from their pre-milked dams gained less weight than calves receiving colostrum (Eaton, Johnson, Spielman, Matterson & Nezvesky, 1949*b*). The gain in weight of the calves improved if vitamin A was given to the dams for 30 days before calving, but even so the gains were lower than those of calves receiving normal colostrum. The differences were not, however, statistically significant, but they may have been masked by the effect of sodium sulphamethazine given as a therapeutic agent when scouring began. Keyes, Reid, Bechdel, Borland, Beam & Williams (1944) found that only four of the calves of twenty-five cows pre-milked for 2-16 days scoured, and these recovered within 7 days; during this time a carotene preparation was given daily. Ackerman, Hyatt & VanLandingham (1949) record the performance of calves from twenty-four pre-milked Ayrshire cows; these grew normally without scouring when given cod-liver oil for the first 3 days. Only nine of these cows gave over 20 lb. of secretion on the day preceding parturition. The authors consider that only such cows give at calving a secretion of the composition of normal milk.

Hill, Widdowson & Maggs (1950) reported the results of a preliminary investigation under practical conditions, and concluded that pre-milking was not detrimental to the health of either cow or calf. It appears from their paper that pre-milking was more often than not restricted to 2 or 3 days before calving, and it therefore seems likely that most of the calves received secretions that differed but little from normal colostrum.

To obtain further evidence on the effect of parturum milking on the health and performance of the newborn calf, equal volumes of either colostrum or of the post-partum secretion of pre-milked cows were given to calves during the first 24 hr. of life. For comparison, the effect of giving the same volume of ordinary milk was also studied.

#### METHODS

##### *Experimental layout*

This experiment was done in the autumn of 1949. A randomized block design was used, with three treatments in each of six blocks of calves, as follows:

No.*	Treatment	
	Initial diet	
10	Colostrum	
11	Milk	
12	Postpartum secretion of pre-milked cows.	

- \* The numbers are consecutive to the numbers given to the treatments in previous experiments.

##### *Diets*

###### *Basic diet*

The calves received one of the initial diets listed below during the first 24 hr. of life, and were then reared for 3 weeks on 'synthetic milk' (Aschaffenburg, Bartlett, Kon, Terry, Thompson, Walker, Briggs, Cotchin & Lovell, 1949). The maximum daily allowance was 1 lb./10 lb. live weight except when scouring occurred (see below).

*Initial diets*

*Colostrum* was collected during the first 24 hr. after parturition from each of five Shorthorn heifers in the N.I.R.D. herd; 1-pint samples were stored separately at  $-25^{\circ}$ . Each calf on treatment 10 was given 5 pints of colostrum consisting of one pint from each heifer.

*Milk.* The afternoon and morning milk given by the same five heifers 14 days after calving was stored at  $-25^{\circ}$ . It was blended and given to calves on treatment 11 in the same way and quantity as colostrum in treatment 10.

*Postpartum secretion of pre-milked cows.* Eleven Shorthorn cows from the N.I.R.D. herd were milked by hand twice daily starting on the 14th day before calving was expected; the mean period of pre-milking with its standard error was  $16 \pm 1$  days. The cows were 'steamed up' for a mean period of  $37 \pm 1$  days before calving with a compound concentrate (National Cattle Food no. 1) starting at 4 lb. daily, and gradually increasing to 8 lb. daily for the last fortnight. The total amount secreted by the eleven cows before calving varied from 1 to 96 l. The variability in total yield agrees with that observed by VanLandingham *et al.* (1949) who found total yields varying from 2 to 142 lb. for eight first-calf Ayrshire heifers pre-milked for 10 days. They suggested that prepartum milking might stimulate the production of lactogenic hormone and pointed out that cows vary in their response to this stimulus.

The secretions to be fed to the experimental calves were collected in the first 24 hr. after parturition from five of the pre-milked cows and were stored separately at  $-25^{\circ}$ . These five cows were chosen as they had responded well to pre-milking by giving a mean total yield before parturition of  $50.7 \pm 5.3$  l. and a mean yield of  $12.8 \pm 2.3$  l. on the day before calving. The secretions were blended and given to calves on treatment 12 in the same way and quantity as with colostrum in treatment 10. All pre-milked cows calved normally, except one not used in this experiment which everted her uterus and developed milk fever.

*Composition.* Samples of rennet whey were prepared from every individual secretion used in blending the initial diets of the calves. The total-nitrogen values of the whey samples are given in Table 1.

Table 1. *Total nitrogen (g./100 ml.) of whey samples prepared from secretions used for initial feeding of calves*

Batch no.	Treatment (no. and initial diet)		
	10 Colostrum	11 Milk	12 Postpartum secretion of pre-milked cows
1	0.794	0.144	0.228
2	2.209	0.152	0.217
3	0.839	0.149	0.233
4	2.145	0.147	0.215
5	1.633	0.148	0.192
Mean	1.524	0.148	0.217

The nitrogen content of the secretions of pre-milked cows obtained during the first 24 hr. after parturition was remarkably uniform. Though higher than that of milk, it was greatly reduced in comparison with that of normal colostrum. As equal volumes of the initial diets were given to the calves, those on treatments 11 and 12 received far less, if any, of the 'immune lactoglobulins' present in the whey of normal colostrum.

The whey samples for which data are listed in Table 1, together with whey samples prepared from the secretions produced on the 1st and 7th days of prepartum milking by the five cows whose secretions were used for treatment 12, were tested for agglutinins against the five strains of *Bacterium coli*, isolated from the calves that died on this experiment. This aspect of our work will be discussed by Briggs in a forthcoming paper of this series (Briggs, 1951). There was a decline in activity during the period of prepartum milking and no agglutinins could be demonstrated in the secretions obtained during the first 24 hr. after calving. Similarly, the samples of milk collected 14 days after calving had no activity, except in one instance in which the corresponding colostrum had an exceptionally high titre.

### Calves

Shorthorn bull calves were collected and managed as in earlier experiments (Aschaffenburg *et al.* 1949). On the arrival of a newborn calf, a blood sample was taken and the globulin-turbidity test (Aschaffenburg, 1949) was applied to the serum to verify that the calf had not suckled. Calves were rejected if the test was positive.

The calves were fed three times daily for the first 10 days of life, and twice daily for the remainder of the experimental period of 3 weeks. If a calf scoured, it was given water, warmed to 37°, at subsequent feeds. When scouring no longer occurred, synthetic milk diluted with an equal amount of water was given, and the proportion of milk was then gradually increased at each feed until the 'synthetic milk' alone was again used. This procedure was repeated when scouring recurred. Records were kept as in the earlier experiments (Aschaffenburg *et al.* 1949).

## RESULTS

### *Performance of calves*

The results for the six blocks of calves are summarized in Table 2.

It is evident that treatments 11 and 12 were inferior to treatment 10; all calves given normal colostrum survived, whereas two calves on treatment 11 and three on treatment 12 died. The differences in the number of deaths between the three treatments were not, however, significant ( $P < 0.2$  between treatments 10 and 12 and  $P < 0.5$  between treatments 10 and 11).

Before comparing the gains in weight and frequency of scouring for the calves on the three treatments, the residual error due to differences between the performance of calves on each block was taken out, the 'missing plot technique' of Yates (1933) being used to calculate values for the calves that died. Analysis of covariance of live-weight gain on birth weight, and analysis of variance of the number of days on which scouring occurred ( $x$ ), with values transformed  $\sqrt{(x + \frac{1}{2})}$  were made.

Table 2. Performance of calves given colostrum, milk or the postpartum secretion of pre-milked cows

	Treatment (no. and diet given)		
	10 Colostrum	11 Milk	12 Postpartum secretion of pre-milked cows
Calves:			
No. used	6	6	6
No. died	0	2	3
Age of calves at death (days) and autopsy finding	—	11*, 14†	5*, 9†, 11*
Adjusted mean live-weight gain of calves during:			
7 days (lb.)‡	+1 ± 1.2	-1 ± 1.4	-7 ± 1.6
14 days (lb.)‡	+2 ± 0.8	-6 ± 0.9	-8 ± 1.1
21 days (lb.)‡	+8 ± 2.4	-7 ± 2.9	-4 ± 3.3
Mean no. of days on which surviving calves scoured‡	3 ± 0.4	6 ± 2.5	8 ± 1.2

\* *Bact. coli* septicaemia.† *Bact. coli* peritonitis and pleurisy.

‡ Values with their standard errors.

The relation between live-weight gain and birth weight of the calves was significant at 14 and 21 days ( $P < 0.01$ ) but not at 7 days. The regression equations were:

Live-weight gain during 7 days (lb.)

$$= -2.57 + 0.08 (\text{birth weight} - 87.26) \quad \text{S.E.} = 2.8.$$

Live-weight gain during 14 days (lb.)

$$= -4.11 + 1.04 (\text{birth weight} - 87.26) \quad \text{S.E.} = 5.7.$$

Live-weight gain during 21 days (lb.)

$$= -0.85 + 1.76 (\text{birth weight} - 87.26) \quad \text{S.E.} = 1.9.$$

There were no significant differences between the number of days on which calves scoured on the three treatments, nor between the adjusted mean live-weight gains during 7, 14 and 21 days for calves on treatments 11 and 12.

Differences were, however, significant between adjusted mean live-weight gains during 14 and 21 days (both  $P < 0.05$ ) for calves on treatments 10 and 11, and during 14 days ( $P < 0.01$ ) and 21 days ( $P < 0.05$ ) for calves on treatments 10 and 12. No significant differences were found between adjusted mean live-weight gains during 7 days for calves on treatments 10 and 12.

#### Autopsy findings

A summary of the autopsy findings is given in Table 2 which shows that all five calves died from a *Bact. coli* infection. Three of the five calves had a *Bact. coli* septicaemia and two died from *Bact. coli* peritonitis and pleurisy.

These two manifestations of 'colibacillosis' may indicate a variation in the resistance of the host but they are basically the same disease; *Bact. coli* is widely distributed throughout the tissues in both.

## DISCUSSION

The findings show that, on a volume basis, the secretion produced in the first 24 hr. after calving by cows that had responded well to pre-milking for a mean period of  $16 \pm 2$  days was, like milk, of less value for the well-being of the newborn calf than normal colostrum.

The results of giving to calves the postpartum secretion from pre-milked cows were no better than those of giving ordinary heifer milk collected 14 days after calving. The relatively poor performance on both these treatments was in keeping with the reduced intake of colostral globulins, and resembles that of calves that, in earlier experiments (Aschaffenburg, Bartlett, Kon, Roy, Walker, Briggs & Lovell, 1951) received small quantities of 'immune lactoglobulins'. The poorer performance is also linked with the decline in the agglutinin content of the secretions, and it is doubtful whether newborn calves, even if given larger volumes of the milk-like postpartum secretion of the pre-milked animals used in our experiments, would get as good a start in life as those receiving normal colostrum. This doubt would hardly arise where, as often happens under practical farming conditions, pre-milking is restricted to the relief of congestion of the udder on the last day or two before calving, since the calf would then receive postpartum secretions differing but little from normal colostrum. It is also possible that the calves used in this experiment were exposed to a greater risk of infection, owing to the presence in the calf pens of susceptible calves from many different farms, than is likely to occur under normal farm conditions.

## SUMMARY

1. Eighteen newborn Shorthorn bull calves, grouped in six blocks, were given normal colostrum, milk, or the secretion produced after parturition by cows pre-milked for 14 days. These diets were fed during the first 24 hr. of life and thereafter the calves were reared for 3 weeks on a standard diet based on dried skim milk.
2. All calves given normal colostrum survived, whereas three given the secretion after prepartum milking, and two given milk, died.
3. There were no significant differences between the frequencies of scouring of calves on the three treatments, or between the mean live-weight gains of calves given milk and the secretion produced at parturition after prepartum milking. The mean live-weight gain at 14 and 21 days, adjusted for birth weight, of calves that had received normal colostrum was significantly greater than that of calves on the other two treatments.

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## The Nutritive Value of Colostrum for the Calf

### 6. The 'K' Antigens of *Bacterium coli*\*

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Smith & Little (1922) drew attention to the protective properties of colostrum against white scours of calves. Since 1946 members of the staffs of the Department of Pathology of the Royal Veterinary College and of the National Institute for Research in Dairying, University of Reading, have collaborated in experiments planned to assess the relative importance of the nutritional and the immunological properties of colostrum for the calf, and have published their findings in several papers (Aschaffenburg, Bartlett, Kon, Terry, Thompson, Walker, Briggs, Cotchin & Lovell, 1949; Aschaffenburg, Bartlett, Kon, Walker, Briggs, Cotchin & Lovell, 1949; Aschaffenburg, Bartlett, Kon, Roy, Walker, Briggs & Lovell, 1951). These workers showed that small quantities of colostrum, of its aqueous fraction and of globulin constituents, protected calves against white scours; the indication was that the mechanism of such protection might be of an immunological nature. The work reported in the

\* This work formed part of a thesis submitted to the University of Reading for the degree of Ph.D., and the substance of it was read at a meeting of the Pathological Society on 6 January 1950.

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